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REPORT

ABBOTSFORD/MISSION WATER AND SEWER COMMISSION

Groundwater Management Strategy: Protection, Management and Governance

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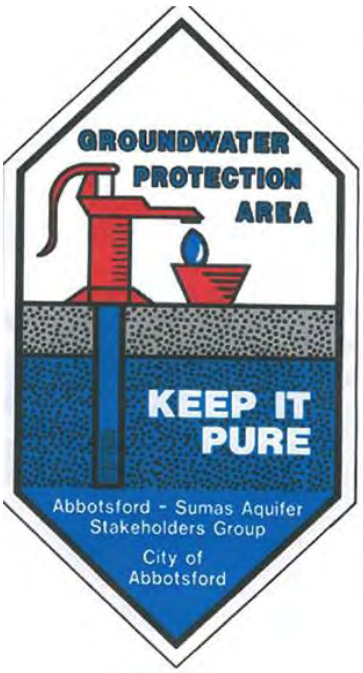

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ACKNOWLEDGEMENTS

The Groundwater Management Strategy has been developed through a collaborative process involving consultation with aquifer users and stakeholders, government agencies, and groundwater experts. The Abbotsford-Sumas Aquifer Science Working Group (ASASWG) (a subcommittee of the City of Abbotsford's Environmental Advisory Committee) and the Abbotsford-Sumas Aquifer Stakeholder Group (ASASG) (a community-based stakeholder group) provided direction for the Groundwater Management Strategy. The ASASWG provided project oversight and input through the development of this document.

The ASASG and ASASWG include representation from the City of Abbotsford (CoA), provincial government agencies, federal government agencies, academic institutions, commercial/agricultural/industrial sectors, water purveyors, non-governmental organizations, the research community, and interested citizens. The CoA thanks members of the above groups and others that have participated in the development of this document, as well as those that have participated in (and continue to participate in) efforts to protect the aquifer.

1.0 INTRODUCTION

1.1 Description of the Abbotsford-Sumas Aquifer

The Abbotsford-Sumas Aquifer is a water-bearing geological formation that extends across the Canada-US border, covering approximately 160 square kilometres in land area, of which about 90 square kilometres is on the Canadian side mostly in the southwestern portion of the City of Abbotsford (CoA). A small portion extends into the Township of Langley (Figure 1). The aquifer is composed primarily of sand and gravel of glacial origins (part of a geological unit called the Sumas Drift) also referred to as glacial outwash. This sand and gravel is quite porous and holds water that has percolated into this material from rainfall at the land surface, and this is commonly referred to as groundwater.

The aquifer essentially acts as an enormous underground water reservoir, with groundwater continually replenished by rainfall. Groundwater ultimately seeps out of the aquifer where it is cut by rivers and streams (forming part of the streamflow) and provides water to wells that pump groundwater from the aquifer. This groundwater is used, and is essential, for many purposes in the community. Since the amount of water in the aquifer is dependent on the annual precipitation (modified by evaporation and plant uptake) that occurs over the aquifer, replenishing or recharging it, and the losses of groundwater through flow into streams and pumping by wells, it is considered a renewable but limited natural resource.

As an unconfined aquifer, having no overlying impermeable layer of silt or clay, it is exposed to the various existing sources (and potential sources) of pollution located on the land surface (pollutants that dissolve into the recharging rainwater at ground level and get transported down into the aquifer). According to the Province's aquifer classification system, it has the highest rating of aquifer vulnerability. Essentially, the properties that make it such a productive source of water also make it vulnerable to contamination from activities at the land surface.

The aquifer contributes to the social, economic, and environmental well-being of Abbotsford as well as neighbouring communities in Canada and the U.S. A discussion of existing information on the aquifer is provided in Appendix A.

Living Water Smart: British Columbia's Water Plan (2008) acknowledges that "groundwater is our hidden treasure" and that protecting its safety and security is essential to communities. It cautions that the limits of any water resource must be recognized and concludes that "the days of taking our 'unlimited' supply of water for granted have passed".

It acknowledges that there is minimal regulation of groundwater in BC and commits to "protect our groundwater from pollution and overuse".

1.2 Groundwater Protection Legislation in British Columbia

W*ho is ultimately responsible for the well-being or condition of the aquifer or for managing the groundwater resource?*

No one government or authority has complete control over the aquifer or total responsibility for managing it to ensure its well-being. Responsibilities for different aspects are shared among different levels of governments and different agencies. More importantly, there is no comprehensive set of laws or regulations to fully address all aspects of aquifer management in order to ensure its sustainability, that is - its ability to continue to serve all its purposes long into the future.

Various governments have specific, and generally limited, areas of interest and responsibility. The federal government, through Environment Canada, is concerned with the cross-border aspects of the aquifer and is working with other agencies and stakeholder groups to minimize contamination and promote aquifer protection measures, as well as continually monitoring groundwater quality in the aquifer. Health Canada is responsible for setting drinking water guidelines for different chemicals and other water quality parameters in water supplies.

In BC, the Crown Provincial asserts ownership of groundwater and partially regulates use of water through various pieces of legislation such as the BC *Water Act* and BC *Drinking Water Protection Act* but does not currently comprehensively regulate the use of groundwater. Provincial agencies in BC, however, have the greatest extent of authority over use of water (surface waters), the safety of drinking water and the prevention of contamination of soil and water from various land-use activities. Currently, the Province is in the process of modernizing the *Water Act* (replacing it with the *Water Sustainability Act*) in order to improve the management of this important Provincial resource.

Furthermore, the BC Ministry of Environment (MoE) regulates well-drilling through the BC Groundwater Protection Regulation. The Regulation established qualifications for those working on wells and pumps, a registry of qualified well drillers and pump installers, and standards for well construction, maintenance, alteration and closure. Its *Environmental Management Act* also contains general provisions prohibiting persons from introducing pollution into the environment. This provision also acts as the legal basis for every person or party who conduct activities above the aquifer to be responsible for those activities from a pollution perspective. No laws exist to regulate either the rates or volumes of groundwater extraction or the resulting impacts, with the exception of the BC *Environmental Assessment Act* that requires an assessment of new wells which would extract more than 75 litres per second. The Abbotsford/Mission Water and Sewer Commission (AMWSC) recently completed this assessment process and received an Environmental Assessment Certificate for the Bevan Avenue Wells Groundwater Supply Development Project on May 24, 2011.

The Fraser Health Authority ensures community water suppliers, such as AMWSC and Clearbrook Water Works District (CWD), distribute potable, uncontaminated water to customers. Section 23 of the *Drinking Water Protection Act* prohibits the contamination of drinking water sources, including well recharge or capture zones. This does not, however, automatically include the use of pollution prevention measures.

The local governments (CoA, Township of Langley) have no direct provision of authority for groundwater use and overall drinking water protection; however, all water purveyors are required to follow provincial certification and reporting requirements. Municipalities also have the general responsibility to provide good government to the community, and this could be interpreted to include managing common resources. Some opportunities lie in the linkage between land-use regulation, water use (or demand) and aquifer protection. For example, it may be possible in some circumstances to prohibit, through zoning, certain high-risk land uses over the aquifer. Municipal bylaws can also be an effective tool to encourage water conservation measures (*e.g.*, lawn-watering restrictions, building requirements and the reduction of impermeable surfaces).

Institutions of higher learning often take responsibility for advancing the knowledge and science of the aquifer; but, they have no mandate or authority to act on that knowledge. The University of British Columbia (UBC), the University of the Fraser Valley (UFV), Simon Fraser University (SFU) and the University of Calgary (UoC) are some institutions that have engaged in research or studies of the aquifer.

Living Water Smart: British Columbia's Water Plan**,** stresses that what government does is only part of the solution and implores community action. It states "together, we need to challenge ourselves and our businesses to think about how we can help protect our water and how the government can support these actions."

The Groundwater Management Strategy (GMS) is intended to set the stage for this cooperative action between community and government to safeguard the Abbotsford-Sumas Aquifer.

1.3 Purpose and Scope of GMS

The purpose of a GMS can be simply described as outlining how to go about addressing the current issues and developing means to manage this valuable natural resource in the future. It clearly must be a co-ordinated and integrated approach as opposed to an isolated one, and must be comprehensive in nature and contain necessary tools and mechanisms in order to ensure success. The GMS must allow for the development of necessary management tools and mechanisms.

It addresses the two key aspects of groundwater quality and quantity, acting as a source water protection plan to address the quality aspect and containing a water supply management component to address quantity. Because of the disparate nature of responsibility for the aquifer, it also prescribes the assignment of actions to specific stakeholders.

While the GMS is being prepared for the AMWSC, the GMS is also considered relevant to the CWD and private well owners that rely on the Abbotsford-Sumas Aquifer (Figure 2). This is reflected by the representation from the CWD and private well owners in the Abbotsford-Sumas Aquifer Stakeholder Group (ASASG).

The GMS primarily applies to that part of the Abbotsford-Sumas Aquifer found within the municipal boundaries of the CoA. At this initial stage, it intentionally does not apply to those parts of the aquifer within neighbouring jurisdictions, whether Canadian or American; however, the strategy could be expanded to incorporate those areas in the future, or, elements of this strategy could be adopted by other jurisdictions.

Do we need to act? Why? What do we need to do?

In light of the numerous threats and serious consequences of not pro-actively addressing those threats, there is an undeniable need to act and to act quickly in order to safeguard and manage the aquifer to ensure sustainable use. Inaction is not an option.

The Province's *Living Water Smart* plan anticipates community intervention noting that:

> *"Around the world there is a trend toward community involvement, resulting in more effective community solutions to managing water. Throughout our province communities are taking action to protect and sustain our water."*

Over the past ten years or more, a coordinating body of community stewards and government agencies has developed and promoted innovative voluntary, non-regulatory stewardship initiatives. Originally established by the CoA to address the growing pollution of the aquifer (nitrate contamination in particular) and while there has been progress on improving the awareness of groundwater issues, the ASASG does not appear to be able to directly influence the resolution of current groundwater problems in the aquifer. Clearly, any groundwater quality improvements to be made will require an entire suite of initiatives, both voluntary and regulatory.

Furthermore, some form of governance framework is also needed to establish accountability on pollution and to address the groundwater quantity issue in order to achieve sustainability of supply.

Since there is no existing single authority responsible for the well-being of this natural resource, it is essential that collectively the stakeholders (both government and non-government), actively intervene in order to ensure that the resource continues to provide adequate amounts of good quality water for all purposes. This effectively requires that we develop a coordinated program of actions and establish the necessary framework and mechanisms to address the issues, threats and problems. This approach or strategy will serve to guide the community's intervention into the future.

1.4 GMS Development Process

How do we go about intervening effectively? How do we go about developing an intervention strategy for managing the aquifer?

Since governments alone neither have the complete authority nor the resources to address all of the issues facing the aquifer, the general public or the community at large must help in addressing this matter. This means all stakeholders - residents, businesses, farmers, - need to do their part for the intervention to be ultimately successful.

As previously noted, a core group of community stewards has already been established in the form of the ASASG. The group has a history of voluntary stewardship and of working cooperatively in the community and with government agencies. It has inherent potential to guide any enhanced stewardship or management initiatives in the future. To optimize its effectiveness, any GMS must be developed through consensus in order to maximize buy-in from the community.

A GMS will need to be a dynamic process that adapts to changing conditions and community needs. It will also likely be iterative in nature simply because all the means developed to address the issues may require fine-tuning or other modification over time. It is anticipated, and even expected, that elements of the GMS may be applied as soon as they are developed. For other matters, not all tools may be currently available and further study may be required. While current issues can be identified and effects potentially foreseeable, any effective resource management plan also needs to be constantly vigilant about emerging problems. This is especially true for groundwater management because remediation of an existing groundwater contamination problem is almost always much more costly than prevention (and not always feasible). Monitoring and assessment are critical to provide this early warning system on emerging issues, for both quality and quantity issues.

1.5 Who is responsible for a GMS?

Who are the stakeholders in the aquifer? Who should be concerned?

Who is responsible for safeguarding groundwater?

No one party or select group of parties has exclusive rights to the aquifer. It is a common resource with many parties having access but none with exclusive rights of ownership. Consequently, many hold a common interest in the aquifer and the development and implementation of a successful GMS.

Historically, the ASASG has recognized three distinct communities of interest among the various stakeholders over the Abbotsford-Sumas Aquifer. Each has significantly different characteristics and operates in significantly different contexts. These are 1) the residential and domestic use community of interest, 2) the ICI or industrial, commercial and institutional sector, and 3) agriculture. While there are, of course, several stakeholder groups within these broader communities of interest, their differences warrant different approaches in the GMS.

Every person or business that uses or affects the groundwater for use as potable drinking water or other purposes can be considered a stakeholder, and should be concerned with its condition. As previously noted, those uses include supplying community water systems or private residential wells, providing process or production-related water for industry and agriculture, and supplying water for irrigation of farms or ICI facilities,

among others. Each user can also either impact water quality, by the way they conduct themselves or how they maintain their property and assets, or can impact groundwater availability, especially in a certain geographic area, by the amount of water they extract from a well or wells in that area.

Also, because of the nature of the aquifer (unconfined with a high vulnerability to pollution), every person or business conducting some activity over the aquifer has a very real potential of impacting the aquifer even if no water is being used in that activity. That is, any controlled or accidental release of chemical or other toxic substances from the land uses above the aquifer have the potential to contaminate by the migration of those substances to the groundwater below that surface. The land uses can either be actual human activities, such as industrial plants or farms, or stationary uses such as pipelines or roadways.

Consequently, all groundwater users and those potentially impacting the aquifer become responsible, in some way, for the condition of the aquifer. However, there currently is no active or widespread voluntary stewardship in the community to substantially address, and ultimately ensure, the well-being of this natural resource. Some examples of voluntary stewardship initiatives do exist in the community. The more permanent and ongoing initiatives include the BC Auto Recyclers (BCAR) Best Management Plans (BMPs) and Code of Practice, the Sustainable Poultry Farming Group's (SPFG's) environmental sustainability program, and the federal-provincial Environmental Farm Plan program. Shorter term initiatives have included awareness and nutrient testing programs by certain agricultural producer groups, such as the raspberry industry, but initiatives such as these have not been sustained.

Figure 1: Approximate Extent of the Abbotsford-Sumas Aquifer.

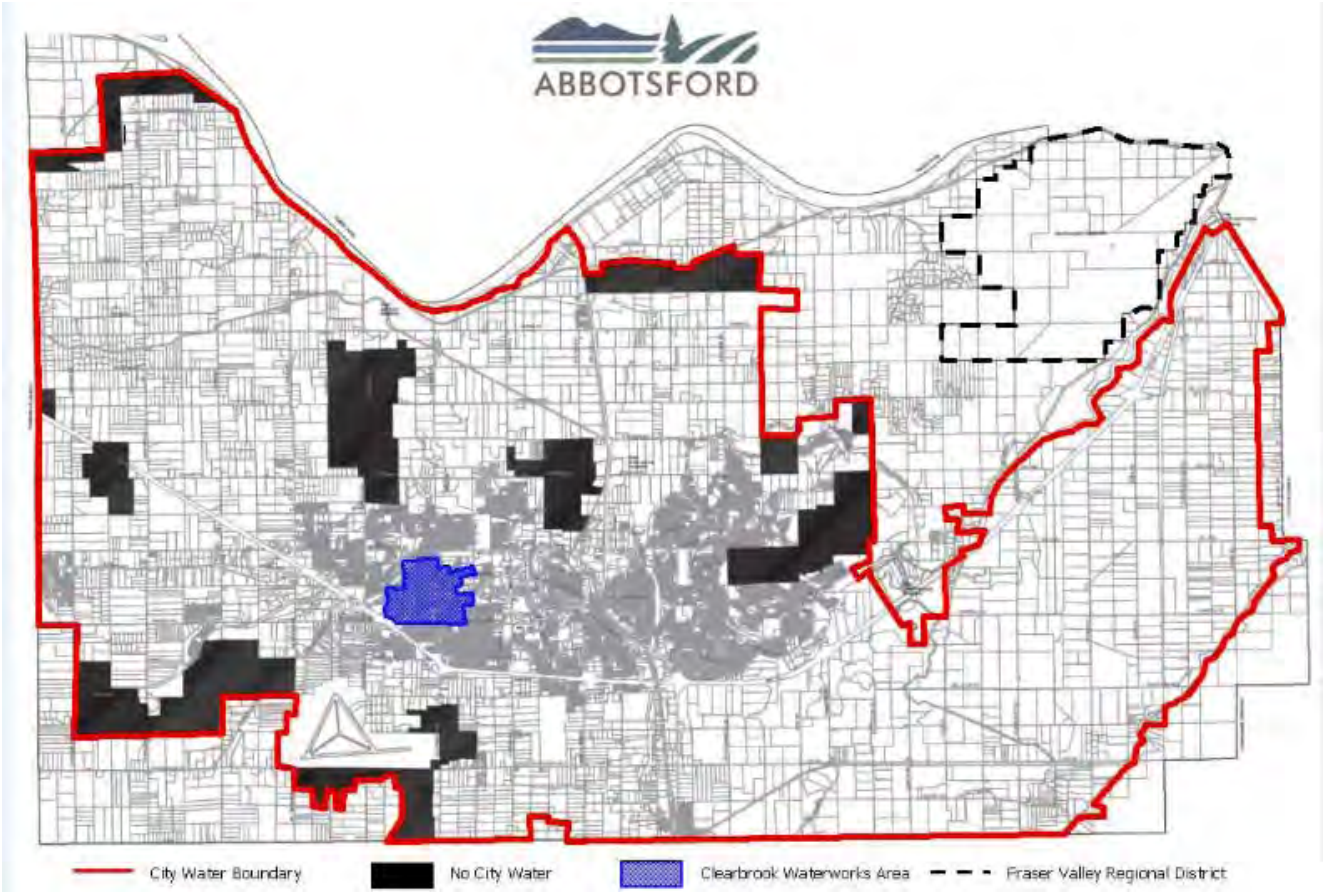

Figure 2: Areas serviced by the Abbotsford/Mission Water and Sewer Commission, Clearbrook Water Works District and Private Water Wells.

2.0 ECONOMIC, SOCIAL AND ENVIRONMENTAL CONSEQUENCES OF INACTION

What happens if we don't act?

In terms of extensive, comprehensive and coordinated community actions, very little has been, and is currently being, done to address the existing and potential threats to both water quality and water availability. While the community and its neighbours have been fortunate in this regard, it would be imprudent to believe that continuing to do business as usual or maintaining the status quo is sufficient. Both unusable water (where degraded quality cannot serve the intended purposes), or lack of water can create serious problems.

2.1 Contaminated Groundwater

Groundwater contamination has occurred in the past in the aquifer. These events have been contained and managed by the parties designated to lead the pollution response efforts (*e.g.*, health authority, agricultural agencies, environmental spill response units, *etc.*). While these ad hoc measures may suffice for isolated pollution events, such as those that have a limited geographic area or are related to spills, accidental releases or other point sources of pollution, they will not be able to address more systemic, widespread and chronic situations. And some widespread chronic (or non-point source) conditions, such as nitrate contamination, have existed for decades.

The *public health effects* of groundwater contamination can be severe, resulting in both acute and chronic effects. The ingestion of microbiological pathogens through the drinking of contaminated water can cause immediate gastro-intestinal illnesses and can be fatal or can permanently damage internal organs and lead to other chronic health problems. Heavy metals such as cadmium, arsenic, mercury and lead are highly toxic and some are carcinogenic, as are some hydrocarbons such as benzene. Some pesticides, pharmaceuticals and industrial solvents are endocrine disruptors (affecting the reproductive system). Nutrients such as nitrate (*e.g.*, from animal manure, fertilizers and septic tanks) can cause methaemoglobinemia in infants and can affect pregnancy. Livestock can also be affected by drinking water with high nitrate concentrations. Nitrate has also been linked to the formation of carcinogens in the human digestive system. Since nitrate does not easily degrade in shallow groundwater, it can be used as an indicator for the potential occurrence of other types of contaminants derived at the land surface. Unfortunately, there are many cases of the health impacts of groundwater contamination in Canada and the U.S., including the May 2000 case of *e. coli* contamination of drinking water (groundwater source) in Walkerton, Ontario.

Economic impacts associated with groundwater contamination range from the costs to secure new sources of water to the ongoing operational costs to treat or filter contaminated water to certain standards or levels of purity based on its intended purpose or use. Contaminated groundwater in a community well could force the establishment of a new well, the cost of which if calculated to include permitting and regulatory expenses as well as capital, could exceed half a million dollars for each well. In a private well it could create the need for expensive extension of municipal water mains and individual hook-up lines, or at the very least, costs for ongoing treatment or filtration of the contaminated water.

For business or industries requiring standard-quality process water, production costs would increase from either installing filtration or treatment systems or purchasing more expensive municipal water if available. For example, some greenhouse operations on the aquifer may need to treat their well-water because of higher concentrations of certain metals in order to make it suitable for their use. Further cost-inefficiencies result if the water quality of the purchased water significantly exceeds the standards required for the business' process water.

The costs of actually remediating the groundwater, as opposed to seeking alternative sources of supply, could be even higher. Previous studies in North America show a cost range of $10,000 to $50,000 per household to clean up an aquifer. Financially, these costs are generally orders of magnitude higher than undertaking pollution prevention measures in the first place (*e.g.*, $1 of prevention avoids $27 of clean-up). More importantly, timeframes for remediation could take years and could sever an important source of supply.

From an environmental perspective, contaminated groundwater that recharges a surface water course could alter the suitability of the aquatic habitat for fish and other species, interfering with spawning and reproduction, or even causing mortality of certain species.

In the event of any emergency situations where the potable water supply from Norrish Creek is interrupted or severely curtailed for any appreciable amount of time, the costs, both human and financial, for the Abbotsford consumers of the AMWSC would be significant. The existing municipal wells over the aquifer would be the sole source of local water that could continue to supply water to the system in such a situation, but the aquifer could not meet the demand, resulting in a water shortage. Groundwater is also required to supplement supply from the Norrish system during peak demand periods (summer droughts, extraordinary fire-flow needs, etc.).

2.2 Water Shortages

Continued unmanaged withdrawals of groundwater can result in loss of water for those with shallower wells (due to a resulting decline in the water table). For rural residents and farms solely reliant on well water, this could result in a loss of potable water for domestic use as well as water used for irrigation or livestock watering. For agricultural processing and other industrial operations, this could mean interruption or even cessation of production and a need to find new and inevitably more expensive sources of industrial process water.

Beyond the immediate costs associated with pursuing emergency or stop-gap measures to replace the loss of water (purchasing bottled water, installing temporary reservoirs), the cost of modifying the existing water supply infrastructure (*i.e.*, drilling a deeper well) or of adding new infrastructure or even changing the supply system (*i.e.*, connecting to a community water system) are significant.

If withdrawal rates approach or start to exceed annual average recharge (precipitation) of the aquifer, then the water table will drop and even generally deeper community wells could be affected. While deepening or drilling new wells in different locations may be an immediate but still extremely costly solution, eventually if the withdrawal problem is not addressed it will require seeking completely alternative sources. As is currently being experienced by the AMWSC, the costs of securing and building the necessary infrastructure for new surface water supply sources are in the order of hundreds of millions of dollars.

Other potential costs, associated with a diminishment of groundwater supply to community water systems (AMWSC, CWD) include the loss of a supplemental source for extreme peak demand periods (*e.g.,* summer drought, extraordinary fire-flow requirements, etc.) and, more importantly, a back-up source in the event of any interruption of supply from the Norrish Creek system (as a result of high turbidity, transmission line disruption or failure, low seasonal water levels, etc.). The cost of replacing groundwater as a back-up is equivalent to that of developing a new source, such as the Stave Lake alternatives (currently ranging in price from $200M to over $300M).

In addition to the economic costs, there are also ecological impacts. A dropping water table, as a result of extraction exceeding recharge, will reduce stream base-flows, compromising fish and other aquatic habitat.

3.0 APPROACH - GROUNDWATER GOVERNANCE

Groundwater governance can be described as the collective interactions of four factors: 1) the mechanisms (policies, initiatives, regulations and public engagement) used to protect the water resource, 2) the agencies and institutions responsible for groundwater management, and their roles, responsibilities and working relationships (*e.g.,* management framework), 3) the financial framework used to fund groundwater management, and 4) the mechanisms for data collection, assessment and reporting to support decision making.

Governance models employed in other jurisdictions were reviewed to identify models that have the potential to be successfully applied to the Abbotsford-Sumas Aquifer. Available literature on groundwater governance was reviewed, together with seven case studies from Canadian and US jurisdictions where groundwater protection initiatives have been undertaken. As part of the case study review, interviews were conducted with representatives from these jurisdictions to inquire about lessons learned. An overview of the results of each case study review is presented in the summary sheets in Appendix B.

A summary of the four aspects of groundwater governance for consideration for the Abbotsford-Sumas Aquifer is presented below.

3.1 Groundwater Protection Mechanisms

Groundwater protection mechanisms can be used to protect groundwater quantity and/or groundwater quality.

Mechanisms may include 1) strategic decisions, such as the decision to extend sewer lines and reduce the potential impact from in-ground sewage disposal, 2) regulatory mechanisms, through the use of provincial legislation or municipal zoning bylaws, 3) non-regulatory mechanisms, such as public education and awareness programs, engaging stakeholder groups, providing technical assistance (*i.e.*, development of best-management plans), and 4) financial incentives.

3.1.1 Formal Provincial Processes

Formal mechanisms for groundwater protection in British Columbia are currently available through the development of Water Management Plans under the BC *Water Act* (administered by BC Environment), and the development of Assessment Response Plans and Drinking Water Protection Plans and under the *Drinking Water Protection Act* (administered by the Ministry of Health). The purpose of Water Management Plans is to resolve conflicts between users, risks to water quality and conflicts between water users and in-stream requirements. Assessment Response Plans serve to identify measures that may be taken to address threats to drinking water, while Drinking Water Protection Plans are to address threats that may pose an imminent risk to public health.

To date, only one municipality in BC, the Township of Langley, has undertaken the development of a Water Management Plan (Interagency Planning Team, 2009). The plan, which was finalized in November 2009, has not yet been approved by the BC government. Since the development of the plan, modernization of the BC Water Act was initiated by the BC Ministry of Environment. The target for completion of the modernization is 2012, at which time the BC Water Act will likely be replaced by a new *Water Sustainability Act*. At the present time, it is uncertain whether provisions will be made for the development of Water Management Plans under the new *Water Sustainability Act*.

3.1.2 Local Planning Initiatives

In the meantime, several water purveyors in British Columbia have proceeded with groundwater protection planning initiatives outside of the formal provincial process. The City of Prince George has made provisions for groundwater protection in their Official Community Plan. The District of Campbell River and the Cities of Cranbrook and Kelowna have established Development Permit Areas to protect groundwater under the *Local Government Act*. Of the latter jurisdictions, the District of Campbell River established a watershed development permit area to limit impervious surfaces to ten percent of the site, and requires an environmental impact assessment to assess cumulative effects and thereby minimize impacts on surface water and groundwater (Okanagan Basin Water Board, 2009). The City of Cranbrook designated industrial and commercial properties in their Wellhead Protection Area as a Development Permit Area for aquifer protection (Okanagan Basin Water Board, 2009). More recently, the City of Kelowna designated Natural Environment Development Permit Areas in its Official Community Plan to protect groundwater within municipal well capture zones (Chapter 12, City of Kelowna Official Community Plan, 2010). In 2009, the Town of Merritt adopted a bylaw for well closure that was developed by the Ministry of Community Development and the Ministry of Environment as a model bylaw for BC communities (Okanagan Water Board, 2009).

Most recently, in 2011, the CoA adopted a Stormwater Source Control Bylaw that applies to new industrial zoned lands located above the Abbotsford-Sumas aquifer. The bylaw requires on-site controls to ensure that stormwater is managed, treated and disposed of in a manner that protects the quality of the groundwater as a drinking water resource. Additionally, within these same industrial-zoned lands above the aquifer, City zoning does not allow industrial uses that pose a high risk to the aquifer (CoA, 2011).

3.1.3 Types of Protection Mechanisms

Groundwater protection mechanisms that may be considered to address groundwater quality and quantity issues are presented in various guidance documents, including:

- Groundwater Bylaws Toolkit, Okanagan Basin Water Board (2009);
- Wellhead Protection Toolkit, Ministry of Environment (2004);
- Groundwater Quality Protection Practices, Golder Associates Ltd. on behalf of Environment Canada (1995); and,
- Wellhead Protection: A Guide for Small Communities, US Environmental Protection Agency (1993).

Case studies have shown that a combination of regulatory and non-regulatory mechanisms is required to effectively protect groundwater. The most successful protection plans are those supported by strong provincial or state legislation. The need for regulatory mechanisms within the Abbotsford-Sumas Aquifer is supported by the Council of Canadian Academies (2009), which commented that voluntary programs alone are not sufficient to protect groundwater quality within the Abbotsford-Sumas Aquifer. The Council stated that Best Management Practices have been developed successfully in certain sectors, such as auto recyclers, but lower levels of success have been experienced with agricultural producers. The Council stated that stricter controls on agricultural producers, industrial operations and individual households would likely be required before aquifer-wide groundwater quality improvements are observed within the Abbotsford-Sumas Aquifer.

Mechanisms for the protection of groundwater quantity include strategies related to water conservation, enhanced infiltration through stormwater management, and/or re-allocation of groundwater and surface water supplies in the context of water balance information.

The protection of groundwater quality could be undertaken through measures implemented within the immediate areas of the municipal wellheads, within the capture zones of municipal and private supply wells, and/or on a regional basis. Mechanisms for the protection of groundwater in the area immediately around the well heads include provisions for well inspection and maintenance, flood proofing, restriction of chemical use and storage at the wellhead, and groundwater monitoring. A range of groundwater quality protection measures could be considered within the capture zones and on a regional basis, depending on the threats. Broader tools include land acquisition (whereby land in vulnerable areas is purchased to allow complete control), the establishment of development permit areas and the use municipal zoning bylaws to restrict land use activities or chemical handling and storage.

3.1.4 Land Use Considerations

Different measures for the protection of groundwater quality could be considered in areas characterized by 1) residential land use, 2) commercial and industrial land use, and 3) agriculture.

Groundwater quality protection measures that could be considered in areas of residential land use include initiatives to educate the public on well and septic system maintenance, and public education and awareness campaigns on the proper use and disposal of household hazardous materials, lawn and garden chemicals and automotive repair substances. Such initiatives have been undertaken previously through the Abbotsford Environmental Pledge Program.

Protection measures for consideration in areas of commercial and industrial land use include the restriction of land use or chemical use and storage through municipal zoning bylaws, controls for above ground and underground storage tanks, engagement of industry-based groups, technical assistance, best management plans, and monitoring and enforcement.

Agriculture represents one of the key land use activities above the Abbotsford-Sumas Aquifer. The case study analysis indicates that the key to implementing groundwater protection initiatives in farming communities is the engagement of agricultural stakeholder groups, together with the provision of financial incentives (*i.e.*, providing farmers with subsidies) to implement groundwater protection-related activities (for example, nutrient management and irrigation plans).

The fact that much of the land use within the CoA has already been established is recognized as a challenge for the implementation of future groundwater protection measures. The province of Ontario is adopting the use of risk management plans under their 2006 *Source Water Protection Act* to allow for the implementation of protection measures in areas that have already been developed. Representatives from Oxford County also advised that employment of a land-use lawyer to advise on options related to land use controls was a valuable investment in their groundwater protection planning process.

3.1.5 Multi-Barrier Approach

Initiatives related to groundwater quality protection should be part of a broader *multi-barrier approach* framework as advocated by the Canadian Council of the Ministers of the Environment (CCME) and used by other jurisdictions in Canada (*i.e.*, Ontario). This approach is an integrated system of procedures, processes and tools that act collectively to prevent or reduce the risks of contamination of drinking water from source-to-tap in order to safeguard public health. Three common components of this approach are source water protection, drinking water treatment and maintaining drinking water distribution systems.

3.1.6 Preliminary Groundwater Protection Measures for Consideration

A summary of preliminary groundwater protection measures that may warrant consideration for the Abbotsford-Sumas Aquifer is presented in Appendix C. The measures were identified to address issues within the following categories:

a) Groundwater sustainability (quantity)

b) Regional groundwater quality

c) Groundwater quality related to Residential land use

d) Groundwater quality related to Commercial and Industrial land use

e) Groundwater quality related to Agricultural land use

For each groundwater protection measure under consideration, a reference is provided to the case study where the measure has been employed.

3.2 Management Framework

3.2.1 Models of Water Governance

There are various water governance management frameworks, as outlined in recent publications by Nowlan and Bakker (2007), Brandes and Curran (2010) and the BC Ministry of Environment (2010). As illustrated by the schematic in Figure 3, the frameworks vary “vertically” based on the degree of federal, provincial and local government control on decision-making, and “horizontally” based on the degree of stakeholder (non-state organizations) involvement.

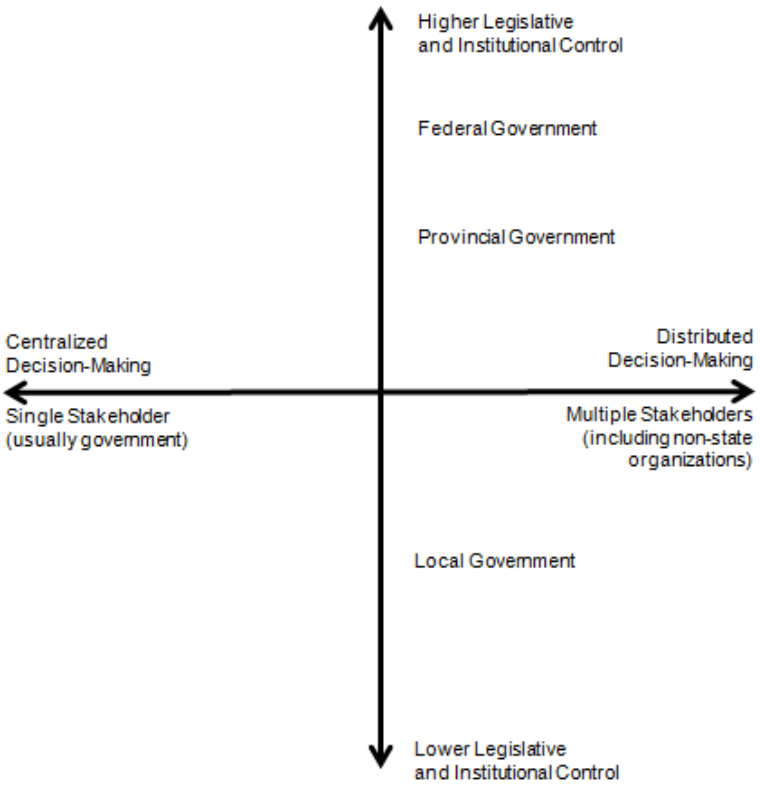

Figure 3: Plot graph of potential groundwater management frameworks
(Reference: Modified from Brandes and Curran (2010) and Nowlan and Bakker (2007))

Recent trends indicate that governments are moving towards a less centralized approach to water management and governance. A collaborative approach to water management decision-making is being undertaken, whereby both government and non-government organizations are involved and stakeholder engagement is enhanced (National Round Table on the Environment and the Economy, 2010). These models typically delegate decision-making to local levels of governments such as the watershed, municipality or region, with support provided at the provincial, and occasionally, federal, level.

The advantages of a collaborative approach to water governance, as outlined by Nowlan and Bakker (August 2010), may include:

- Access to "local" expertise which can improve the quality of decision-making;
- The ability to adapt regulatory programs to meet local conditions;
- Empowerment of stakeholders (particularly those traditionally marginalized);
- Reinforcement of "social trust" between stakeholders and reduction of conflict over competing uses;
- Greater cooperation in information-sharing;

- Greater political legitimacy (and thus enforceability) of water management planning outcomes; and,
- More positive outcomes that have the buy-in and support of influential interests.

Possible disadvantages of collaborative approach to governance, also outlined by Nowlan and Bakker (August 2010), may include:

- A focus on local environmental interests may exclude regional or national environmental concerns;
- Emphasis on consensus may lead to politically workable solutions, rather than environmentally optimal solutions;
- Unequal representation of stakeholders may develop at the local level;
- Long-term stability may be undermined by large amounts of volunteer time required ("burnout"); and,
- There may be greater overall costs and more time required to produce outcomes such as water use or watershed plans.

In discussions related to the development of the *BC Water Sustainability Act* (BC Environment, 2010), three models of governance were put forward for consideration by the province: 1) a centralized approach whereby planning and decision making is undertaken at the provincial level, 2) a shared approach whereby planning and decision making is undertaken at the provincial and local level within a provincial framework, and 3) a delegated approach, whereby planning and decision making is undertaken at a local level within a provincial framework. For the delegated approach, consideration is being given to the development of new "watershed agencies" to influence land use planning and development activities. Feedback on the proposed BC *Water Sustainability Act* (BC Environment, December 2010) received by the BC government through workshops, surveys and written submissions yielded no clear support for a single governance model.

In the absence of a current provincial strategy on groundwater governance, available research and lessons learned from the case studies indicate that the best model for governance of the Abbotsford-Sumas Aquifer is a shared, collaborative approach, whereby planning and decision making is undertaken at the local level with significant support from the provincial government, together with stakeholder involvement. Given the fact that the Abbotsford-Sumas Aquifer represents a trans-boundary aquifer, a level of federal support is also likely necessary.

The "local-level" planning and decision-making described above, whereby the process is led by the CoA, may be the most suitable approach for the Abbotsford-Sumas aquifer. This governance structure could be re-considered if the provincial government decides to further their initiatives towards the development of new "watershed agencies". However, at this time the development of a "watershed agency" for water management within the CoA may not be ideal because, while it would presumably allow for the integrated management of both surface water and groundwater, the jurisdiction of such an agency is unlikely to correspond to the aquifer boundaries. Furthermore, lessons learned from the development of the Water Management Plan for the Township of Langley indicate that a proposal for the development of a new water management agency in that jurisdiction was not well-received.

3.2.2 Elements for Success

Case studies have shown that in order for the proposed governance model to be successful, the following groundwater management elements are required:

3.2.2.1 Effective Leadership

Other jurisdictions have reported that while there are significant advantages to obtaining broad-based input in the development of the groundwater management plan, decision-making via committee can be an arduous process. Furthermore, in their report on the Sustainable Management of Groundwater in Canada, the Council of Canadian Academies (June 2009) commented that a perceived governance gap currently exists for the Abbotsford-Sumas Aquifer due to the numerous agencies charged with aquifer management. Specifically, Environment Canada is responsible for the trans-boundary effects within the aquifer, BC Environment is responsible for pollution prevention and control, the Fraser Valley Health Authority is responsible for drinking water and community health, the BC Ministry of Agriculture and Food is responsible for agricultural issues, the AMWSC and the CWD are responsible for drinking water management in their roles as water purveyors and the CoA is responsible for land-use planning (Conference Board of Canada, 2006).

There is the need for a lead agency that would be committed to the development of the plan and would take responsibility for championing the project. Lessons learned from other jurisdictions indicate that this will require a high level of staff commitment and Council support. Representatives from the Township of Langley indicated that during the development of their Water Management Plan, employment of a professional facilitator helped to focus the management committee and resolve conflicting positions.

3.2.2.2 Funding

Ensuring a level of sustained funding is an essential element to the successful development and implementation of groundwater management plan. Jurisdictions without this funding, such as the Southern Willamette Valley area in Oregon, have stressed that without it, their efforts have become stalled. Potential sources of funding are described in Section 3.3.

3.2.2.3 Clear Objectives, Scope and Schedule

Another key to successful groundwater management is the development of clear objectives for the project, together with a manageable scope of activities and associated schedule.

The overall objective of the Groundwater Management Strategy is the protection of groundwater quality and quantity within the geographical area that corresponds to the CoA. While the intent of the current strategy is to focus on groundwater management, consideration could be given to integrating provisions for surface water management in the future. The current strategy considers the protection of both municipal and private groundwater supplies. According to the C.D. Howe Institute (Bruce, February 2011), the preservation of ecosystem viability represents another major principal of effective groundwater management.

A preliminary scope of activities for consideration is provided in a Suggested Action Plan Framework introduced in Section 5.0 of this document; further refinements are required to determine the details of this plan, including the scope of work, responsible parties, schedule and budget for each task.

3.2.2.4 Committed Participants

In order to ensure success, collaborative governance requires that the right participants be involved, and that those individuals are fully committed to the process, their roles are well-defined, and they are held accountable to their commitments. In the case of government participants, case studies have shown that it is advantageous for those participants to have decision-making authority.

Water governance partnerships can take various forms, depending on the duration (short or long-term) and decision-making power (advisory versus authoritative) of the partnership. Short-term advisory processes consist of collaboration amongst diverse stakeholders over a specific issue of limited duration, while longer term advisory processes involve a range of governmental and non-governmental stakeholders over a relatively long time period (*i.e.*, five years or more) (Nowlan and Bakker, 2007). Short-term authoritative processes are intended to provide specific input from experts into policy reform over a short (one- to two-year) period, while long-term authoritative partnerships are formalized bodies with implementation power for water management decisions (Nowlan and Bakker, 2007). The Abbotsford-Sumas Aquifer Technical Working Group has identified the need for a governance partnership of long-term duration. Short-term partnerships may be required on an as-needed basis to address specific issues. Authoritative bodies of long-term duration are rare in Canada; examples include the Okanagan Basin Water Board and Ontario's Conservation Authorities (Nowlan and Bakker, 2007).

3.2.2.5 Sufficient Scientific Information

The Groundwater Management Strategy must be predicated on sound science to ensure that any mechanisms identified by the Strategy are technically and legally defensible. Preliminary data gaps are described in the Suggested Action Plan Framework introduced in Section 5.0.

3.3 Financial Framework

The case study review indicates that sustained funding is essential to the development and implementation of a successful groundwater management strategy.

Funding is required to conduct the technical studies needed to support the strategy, for the consultation and planning process, for the staffing required to implement the strategy, and for the on-going management and monitoring of the resource. Jurisdictions such as Dayton, Ohio and Waterloo, Ontario employ a number of permanent staff dedicated to long-term groundwater resource management.

Significant funding may also be required to support the management mechanisms identified by the strategy. For example, Oxford County has dedicated funds to land acquisition in sensitive areas, while Dayton, Ohio has made funds available for clean-up of contaminated sites. Capital expenses may be required in areas where, for

example, a decision is made to extend sewer lines to protect groundwater quality. Money may also be required to fund incentive programs for farmers and other commodity groups. In Dayton, Ohio, incentives are provided to businesses that can show they have reduced their chemical inventories by 97%.

In most jurisdictions where successful plans have been developed and implemented (such as Ontario and New Brunswick), significant funding support has been provided by the province or state. Groundwater management initiatives are also supported by local government funds. On-going funding for groundwater management initiatives are funded by water rates in the County of Oxford and Dayton, Ohio. In Canada, cities such as Toronto, Guelph and Halifax have started water price re-structuring with reported success (Municipal World, March 2011). Guelph, Ontario, which relies entirely on groundwater as its water source, charges its residents about $2 for every cubic metre of water used. This charge comprises a low, fixed charge of about $13/month, combined with a variable charge (on a per-meter basis) for water and wastewater (Brandes, March 2011). Recognizing the cost associated with water metering, some communities recover water charges without the benefit of metering. In Dayton, Ohio, much of the initial funding for groundwater protection planning was reportedly derived from insurance money provided in response to a major fire in an industrial area. This 1987 fire, which threatened local groundwater quality, was one of the key triggers for the development of Dayton's well field protection program (Dayton, 1991).

3.4 Data Collection Mechanisms

A significant amount of scientific data has been collected from the Abbotsford-Sumas Aquifer over a period of decades as a result of the involvement of federal, provincial, state and academic institutions. In particular, considerable information has been gathered concerning the rising nitrate concentrations in the aquifer (Nowlan and Bakker, 2007). A summary of studies undertaken by these agencies, together with available protection tools and protection initiatives undertaken by stakeholder groups, is provided in Appendix D. Other data gaps, where additional information or updated studies are required, are discussed in the Suggested Action Plan Framework presented in Section 5.0.

According to the Canadian Council of Academies (2009) and Nowlan and Bakker (2007), the challenge for the management of the Abbotsford-Sumas Aquifer is not the lack of data but rather the absence of formal mechanisms whereby technical data can be translated into specific policies and actions. Once a management structure is selected and a commitment to moving forward is established, existing and future data can be integrated into the decision-making process.

3.5 Performance Measurement

A successful groundwater management strategy requires a formal mechanism to evaluate the results of the strategy and make adjustments, where necessary. Elements of this evaluation include on-going monitoring and assessment of groundwater quality and quantity, evaluation of the effectiveness of the management activities, and reporting.

Provisions for monitoring related to groundwater sustainability may include monitoring of groundwater levels, groundwater extractions and associated stream baseflows. Groundwater quality monitoring may be conducted at community water wells, at strategic locations as an early warning of impending water quality concerns, or on regional-basis to assess long-term water quality trends (for example, nitrate concentrations).

The evaluation of management activities should consider whether new information should be added to the plan, whether the objectives of the plan are being met, identification of adjustments or improvements to the strategy, and the schedule and budget status.

4.0 FUTURE PRIORITIES FOR GROUNDWATER MANAGEMENT – INPUT FROM OCTOBER 5, 2011 STAKEHOLDER WORKSHOP

A workshop with the Abbotsford-Sumas Aquifer Stakeholder Group was held on October 5, 2011 to present the results of the literature and case study review and to obtain feedback on the preliminary groundwater protection measures identified by the study. The evaluation and prioritization of proposed groundwater protection measures was carried out independent of existing groundwater protection initiatives. The identification of protection measures that are already underway during the consultation process (i.e. a Stormwater Source Control Bylaw, a water conservation program, water restrictions and water conservation measures) provided an independent endorsement of these initiatives.

4.1 Criteria for Evaluating Groundwater Protection Measures

The potential groundwater protection measures (introduced in Section 3.1) were evaluated based on criteria that were derived from the elements for success identified in Section 3.2.2. These criteria are summarized as follows:

- Effectiveness – How effective will the groundwater protection measure be? Will the effect be measureable?
- Governance Framework – Is there political support and a designated lead agency to assume responsibility for implementation of the protection measure?
- Data – Is there sufficient data available to develop the protection measure and to ensure it is technically (and legally) defensible?
- Funding – What is the relative cost of the protection measure; are there sufficient resources to implement and support it?
- Regulatory Support – Is there an existing regulatory framework to support the protection measure? If not, how easy would it be to enforce the required measure?

It was initially proposed that “effectiveness” represented the most important of the evaluation criteria, and it was given a relative weighting of about 40%, with the remaining four criteria representing relatively equal weightings of 15%. Based on an evaluation of the criteria carried out at the start of the workshop, most participants agreed that “effectiveness” represents the most important evaluation criterion (40.4% weighting). Of the remaining criteria, “governance framework” was considered the next most important (with a relative weighting of 21.2%), followed by regulatory support (17.3%), funding (17.3%) and data (3.8%). Discussions over the course of the workshop did not alter the relative importance of these criteria for the participants but there was a slight adjustment in the weightings of the criteria by the end of the workshop, with final weightings (based on participant votes at the end of the workshop) of 35.9% for effectiveness, 20.5% for governance framework, 18% for regulatory support, 12.8% for funding and 12.8% for data. Participants recognized the inter-relationship between the criteria. Specifically, some participants recommended that the “governance framework” and “regulatory support” criteria be combined. Others recognized the importance of public/stakeholder support and coordination/communication, and suggested expanding “regulatory support” to include these forms of support. A summary of additional comments on the evaluation criteria from the workshop is provided in Appendix C.

4.2 Prioritization of Potential Groundwater Protection Measures

Participants in the stakeholder workshop used the criteria described above to evaluate each of the proposed groundwater protection measures. The advantages and disadvantages of each measure were first identified by the participants, and then the measures were priority ranked with respect to each of the following five categories: 1 - groundwater sustainability, 2 - regional groundwater quality, 3 - groundwater quality related to residential land use, 4 - groundwater quality related to commercial and industrial land use, and 5 - groundwater quality related to agricultural land use.

A summary of the stakeholder feedback on the proposed groundwater protection measures is provided in Appendix C. The resultant priority rankings of the potential groundwater protection measures are summarized below, and may be used as a basis for future groundwater protection planning.

Table 1: Category 1 - Groundwater Sustainability - Ranking of Potential Groundwater Protection Measures

Description of Protection Measure	Priority Ranking
Public education on water conservation	1
Water use charges using: 1) a flat-rate billing structure that would not require metering, 2) a variable rate based on metering[1], or 3) a combination of the two	2
Requirements for well siting/drilling/groundwater extraction, with focus on large groundwater users (for example, mandate drilling authorizations for new wells, require hydrogeological assessments and monitoring for large groundwater extractions, or set limits on pumping volumes)	3
Enhance infiltration (groundwater recharge) through improved storm water management (*i.e.,* impose limitations on impervious surface areas)	4
Water use restrictions using municipal bylaws (for municipal water users/private well owners)	5

Table 2: Category 2 - Regional Groundwater Quality - Ranking of Potential Groundwater Protection Measures

Description of Protection Measure	Priority Ranking
Establish development permit areas corresponding to municipal well capture zones or sensitive parts of the aquifer within the Official Community Plan to restrict land use and/or activities (may include provisions for storm water management, best management practices, monitoring)	1
Improve the quality of storm water recharging the aquifer through enhanced treatment (*i.e.,* wetlands, biofiltration, oil-water separators) and monitoring controls	2
Implement a comprehensive groundwater monitoring and assessment program to inform future decision-making	3
Spill response planning/training/reporting (first responders to be made aware of sensitive groundwater areas, such as municipal well capture zones, and specific provisions within those areas, such as restrictions on the use of hazardous fire retardant chemicals)	4

[1] Metering and water use charges already occur in the CWD and AMWSC service areas.

Table 3: Category 3 - Groundwater Quality Related to Residential Land Use - Ranking of Potential Groundwater Protection Measures

Description of Protection Measure	Priority Ranking
Require on-going inspection/maintenance of approved septic systems (for example, permit to be renewed every 3 or 5 years, or in the event of a property transaction)	1
Public education on well maintenance; septic system maintenance; and proper use and disposal of household hazardous materials, lawn and garden chemicals and automotive repair chemicals (pamphlets, door-to-door visits, information sessions)	2
Require minimum lot sizes and enhanced design controls (*i.e.,* nitrogen removal systems) for septic systems in sensitive areas to reduce impact on groundwater quality	3

Table 4: Category 4 - Groundwater Quality Related to Commercial and Industrial Land Use - Ranking of Potential Groundwater Protection Measures

Description of Protection Measure	Priority Ranking
Restrict land use and/or chemical storage and use in municipal capture zones or sensitive groundwater areas through municipal zoning bylaws (*i.e.,* prohibit high-risk commercial and industrial activity and/or impose controls)	1
Requirements for sand and gravel mining - best management plans with provisions for fill characterization, drainage control, groundwater monitoring, closure plans; prohibit sand and gravel mining in sensitive areas	2
Engage stewardship groups/provide technical assistance to assist businesses with the development of best management plans	3
Enhanced requirements for above-ground and underground storage tanks (i*.e.,* provisions for spill containment, reconciliation records, pressure testing, groundwater monitoring)	4

Table 5: Category 5 - Groundwater Quality Related to Agricultural Land Use - Ranking of Potential Groundwater Protection Measures

Description of Protection Measure	Priority Ranking
Stewardship programs (for example, encourage participation in Environmental Farm Plan Program sponsored by the BC Agriculture Research & Development Corporation)	1
Provide financial incentives to farmers to assist with nutrient management, integrated pest management, grazing management, irrigation management, water management and riparian management.	2
Provide free technical assistance to farmers on issues related to nutrient management and irrigation (agro-consultants)	3

5.0 NEXT STEP – DEVELOPMENT OF AN ACTION PLAN

As discussed in Section 1.0, the key objectives of the Groundwater Management Strategy are 1) to ensure adequate groundwater supply for existing and future ecological needs and 2) to preserve and enhance groundwater quality in the Abbotsford-Sumas Aquifer for both municipal and private groundwater users. These objectives can best be met through the development of an Action Plan. The Action Plan should identify outstanding issues related to groundwater quality and sustainability, data gaps and information required to address these issues, key protection strategies for consideration, a lead agency for each action, and a schedule and budget for implementation. Potential groundwater protection measures evaluated at the October 5, 2011 stakeholder workshop will help to prioritize future actions.

5.1 Suggested Action Plan Framework

A Suggested Action Plan Framework, developed based on the general issues related to groundwater quantity and quality described in Section 2.0 and Appendix A, together with feedback on prioritization of potential groundwater protection measures obtained from the October 5, 2011 stakeholder workshop, is presented in Appendix E for consideration. Additional studies and initiatives that are currently being undertaken by the government and community stakeholders are listed in Appendix D. One readily apparent data requirement of the Action Plan is the development of a Contaminant Inventory, which is described below.

5.1.1 Contaminant Inventory

A contaminant inventory is required before decisions concerning groundwater quality protection can be made. Contaminant inventories can be conducted at a regional basis (*i.e.*, across the aquifer), within individual capture zones (the areas contributing groundwater to an individual water supply well), and at the wellheads themselves, to identify potential threats to groundwater quality. Previous regional contaminant inventories, if available, should be updated and contaminant inventories for capture zones of municipal water supply wells should be conducted. Preliminary capture zone analysis has been conducted for municipal water wells operated by the AMWSC using analytical methods (Piteau, November 2010); consideration could be given to whether these capture zones should be refined using numerical modelling, and whether capture zone delineation for water supply wells operated by the CWD and private suppliers is required.

5.1.2 Risk Assessment and Management

Realistically, not all threats or hazards to water quality (or quantity) can be eliminated; however, they must still be addressed or mitigated through a risk-management process. This process identifies existing and potential hazards to drinking water, assesses their potential impact on potability and corresponding public health and explores ways of dealing with or even eliminating those hazards. For a risk management approach to be successful it must document or identify all known or potential hazards. Similarly, these hazards need to be assessed in terms of their potential risk or chance of causing harm. Risk assessments may need to be based on more qualitative criteria as opposed to more scientific quantitative data simply because of a lack of availability of information. Most importantly, the basis for the actual risk assessment needs to be apparent to affected parties. Consequently, risks are prioritized and managed. Where hazards cannot be eliminated or risks accurately measured, Best Management Practices may provide the most valuable tool for addressing them.

In addition to identifying the higher risk potential sources of contamination, the delineation of migration pathways and significant receptors on the aquifer is also necessary to undertake successful risk management efforts. Table 6 offers an example of a possible Risk Framework identifying priority areas requiring attention. This matrix correlates different types of activity based on their relative potential as sources of contamination with the relative sensitivity of the different geographic areas or locations over the aquifer, resulting in a qualitative ranking of relative priority from HIGH to LOW.

Table 6: Possible Risk Framework for Prioritization of Pollution Prevention Actions

Contaminant Source	Recharge Area	Well Capture Zone	Wellhead (Private Well)	Wellhead (Community Well)
High risk activity	MEDIUM	HIGH	HIGH	HIGH
Mod risk activity	LOW	MEDIUM	HIGH	HIGH
Low risk activity	LOW	LOW	MEDIUM	MEDIUM

5.2 Action Plan

The Suggested Action Plan Framework is presented in Appendix E. As previously stated, many hold an interest in the aquifer, together with the development and implementation of a successful GMS. Implementation will require a cooperative effort among stakeholders. The ASASG and the ASASWG will work to identify immediate; mid- and long-term actions to implement the GMS, in addition to the stakeholder(s) best equipped to lead the action to a successful outcome.

5.3 Conclusion

Lands above the Abbotsford-Sumas Aquifer support commercial, industrial, residential and agricultural activities and, as such, those engaged in these activities are important stakeholders in ensuring the aquifer is protected. A number of users rely on the aquifer as a water source, including residents and businesses serviced by the AMWSC and CWD, as well privately owned wells in the City of Abbotsford and the Township of Langley; additionally, the aquifer supplies water to City of Sumas residents. It is important to recognize that initiatives and actions undertaken by any stakeholder or user group will have benefits for all users of this shared resource and the Groundwater Management Strategy outlined in this document provides a framework for the future protection, management and governance of the Abbotsford-Sumas aquifer to be implemented by all aquifer stakeholders and users.

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APPENDIX A

Overview of the Abbotsford-Sumas Aquifer

April 12, 2012
Report No. 10-1435-0013

Golder Associates

IMPORTANCE OF THE ABBOTSFORD-SUMAS AQUIFER

The Abbotsford-Sumas aquifer contributes to the social, economic, and environmental well-being of Abbotsford as well as neighbouring communities in Canada and the U.S.

As a source of potable (clean) drinking water for a number of community water systems, it is essential for the good health of most of the residents of Abbotsford and neighbouring communities. The aquifer plays a significant role as a back-up source for the Abbotsford Mission Water Services (AMWSC) water system, providing supplemental supply during peak summer usage periods and during drought conditions. It is also the emergency supply for Abbotsford in the event of any disruption of the transmission of water from the Norrish Creek system north of the Fraser River.

The aquifer is the sole-source of supply for the approximately 13,000 residents of the CWD, hundreds of private well-owners in south Abbotsford, and for numerous water systems in the US, including the City of Sumas.

The economic importance of the aquifer is demonstrated in its diverse range of uses and applications as a result of its traditionally high quality of water and, to date, its assuredness of supply or quantity. It also offers a major competitive advantage to high volume water users on their own wells who rely on its affordable price in order to help minimize production costs. The local farming community and many agri-businesses also make extensive use of groundwater for watering, irrigation or processing. Numerous industries, including both food processing plants and other non-food related industries, have their own production wells and enjoy the economic benefits of this low-cost resource as opposed to incurring the higher costs associated with municipal water systems.

Further, because the municipal system has limited capacity in many rural areas and cannot provide all agricultural needs, groundwater may be more than just a low-cost alternative. For many agricultural operations, from livestock to crops, groundwater is critical for watering or irrigation.

Groundwater is also used for the irrigation of sports fields and landscaped areas by both the City and other institutions such as local colleges. New applications are also being created in the development industry sector where more sustainable and economic geo-heat exchange systems are replacing conventional HVAC systems in residential and Industrial, Commercial and Institutional (ICI) buildings. Furthermore, as an emergency supply source for the municipal water system, the aquifer helps protect hundreds of millions of dollars of property and related investment through its role in fire-fighting or fire suppression.

From an environmental perspective, the aquifer both directly and indirectly supports ecological well-being. Directly, in different geographical locations, groundwater from the aquifer discharges naturally to watercourses helping to maintain stream flows (providing the base-flow component of stream flow) particularly in dry summer months and moderating stream water temperatures for fish and other aquatic life (since groundwater is usually cooler than surface water). Indirectly (through pumping of groundwater), the aquifer contributes high volumes of good quality water for the rearing of freshwater fish at the Fraser Valley Trout Hatchery.

GROUNDWATER QUALITY

Groundwater Quality Trends

Because the aquifer covers such a large area, its water quality varies significantly across the aquifer and over time (spatially and temporally). In particular, there are occurrences of higher concentrations of contaminants in certain geographic areas or apparent “hot spots” of poor quality in the aquifer. Even these locations may have seasonal variances.

The 1995 Provincial Fraser Valley Groundwater Monitoring Program identified dissolved nitrates, pesticides and some synthetic hydrocarbons, from water wells, in the aquifer (BC Ministry of Health et.al., 1995). Monitoring since that time has detected coliform bacteria as well (Environment Canada et. al., 2006). However, the most significant and persistent contaminant of concern over the past few decades is inarguably nitrate.

As an example of the variable water quality that can be found in the aquifer due to contamination from land use practices, Figure A-1 (McArthur and Allen, 2005) below demonstrates the spatial distribution of the areas of higher nitrate concentrations or apparent nitrate hot spots.

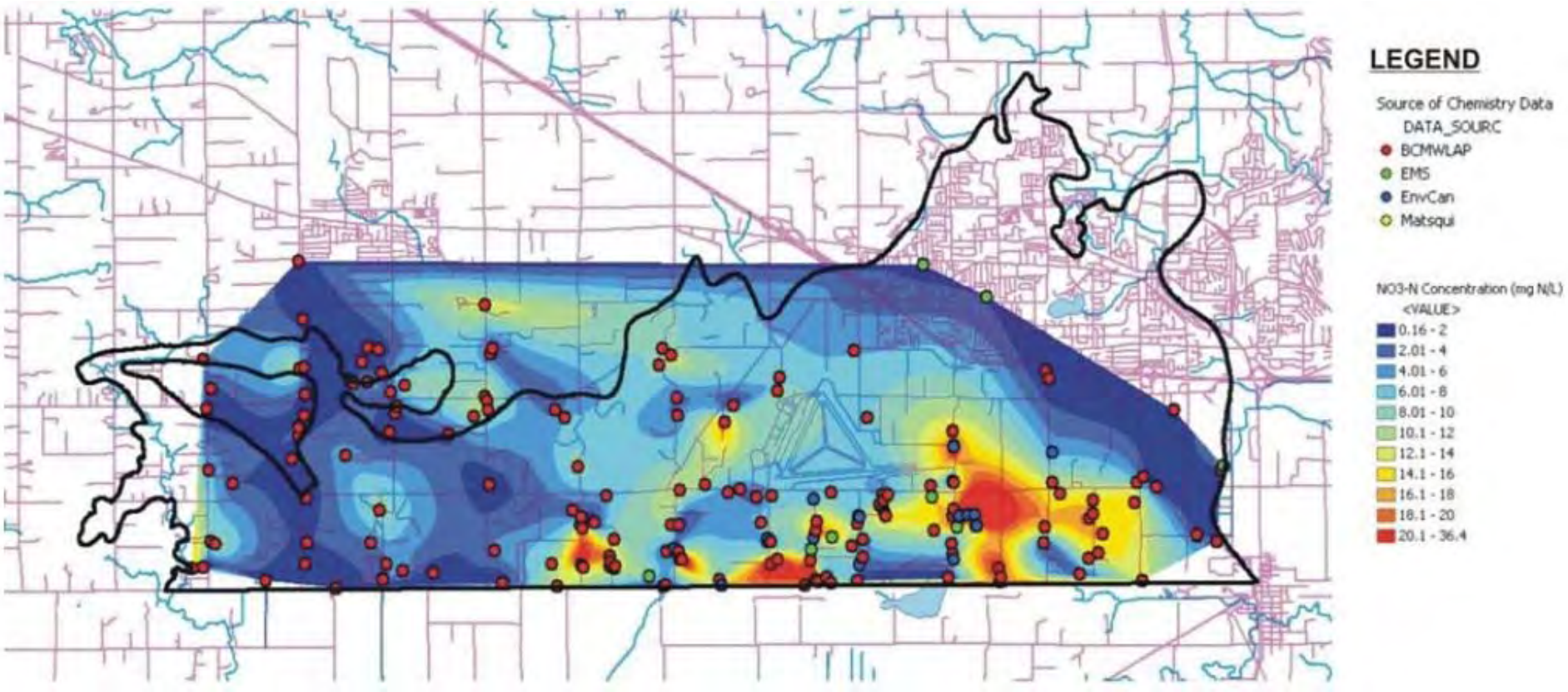

Figure A-1 Nitrate distribution from 2002 to 2004 in the Abbotsford-Sumas aquifer

Reference: Figure 12 from "*Abbotsford-Sumas Aquifer Compilation of a Groundwater Chemistry Database with Analysis of Temporal Variations and Spatial Distributions of Nitrate Contamination*", by McArthur, S. and D. Allen, Department of Earth Sciences, Simon Fraser University, February, 2005. Prepared for British Columbia Ministry of Water, Land and Air Protection Climate Change Branch.

Fortunately, nitrate values in community wells (CWD and AMWSC) are not a problem since these wells have generally not been located in these “hot spot” areas, although some exceedances have occurred from time to time in some City wells. In such cases, the relatively low rates of concentration have allowed the wells to continue to be used based on the dilution factor when the groundwater mixes with the larger surface water-sourced volumes in the system.

Nonetheless, average nitrate concentrations over the past decade or more have not abated and continue to be a serious concern for groundwater users on the US side of the international border.

Threats to Groundwater Quality

An unconfined aquifer is typically vulnerable to the entry of contaminants from the overlying land surface. The abundant rainfall in the Abbotsford area eventually washes most substances down to the water table (often dissolved into the water as it percolates down from the land surface). This results in the constant threat of the groundwater being drawn by wells to be potentially contaminated for drinking water, irrigation or industrial process purposes.

The sources of contaminants found over the aquifer are many and varied, and as a result the types of contaminants are also extensive because of the wide variety of sources. The most common types of contaminants include:

- Organic Chemicals (hydrocarbons, pesticides, solvents, pharmaceuticals, etc.)
- Inorganic Chemicals (heavy metals – *e.g.*, lead, copper, chromium, arsenic)
- Nutrients (nitrogen/nitrate, phosphorus)
- Microbiological Pathogens (pathogenic bacteria, protozoa and viruses)

While each land use activity above the aquifer has its own content of potential contaminants, they can all be characterized as either point sources or non-point sources (diffuse sources). There can also be temporal variability associated with these, such as being seasonal in nature or having random (*e.g.*, spills) or regular frequency.

Point sources can include leachate from old landfills, septic systems, leaking above-ground or underground storage tanks, road spills, stormwater outfalls, pipeline leaks and ruptures, dumping of dry-cleaning solvents or industrial solvents or chemicals, and even uncapped abandoned wells or improperly sealed existing wells. The relatively recent phenomenon of clandestine drug labs also creates an additional significant source of point source contaminants due to the large volumes of industrial solvents and chemicals used in these activities.

Nonpoint sources can include the accumulation of nutrients (primarily nitrate and phosphate), fecal matter and other contaminants on agricultural lands, urban parks, residential or other urban lawns and landscaped areas; atmospheric deposition of airborne pollutants; and contaminants associated with roads, rail corridors, and airport runways, *etc.*

The aquifer is the pathway for contaminants to migrate or travel from the source to the receptor. The main receptors are, of course, the multitude of wells and streams or other surface water bodies where the groundwater eventually is drawn back to, or reappears at, the surface. As previously noted the receptors use the water for potable or drinking water purposes, for irrigation or livestock watering, and for industrial (including food) processing. Fish and other aquatic life are immediate receptors of groundwater that naturally discharges to surface waters. It is important that groundwater quality is not degraded to the detriment of human needs and aquatic life. Certain concentrations of specific contaminants, along with variations in temperature, could render the water unusable (as outlined in provincial and federal water quality guidelines for aquatic life).

Prioritization of Threats

Many threats exist but, practically, these cannot be addressed all at once given currently limited community and external resources. Consequently some form of prioritization is needed to allow a strategic approach to be developed that would address the most important or critical threats.

The significance of any threat to groundwater quality is determined by a number of factors including:

- The amounts or volumes of potential contaminants used or stored
- The toxicity of substances or potential contaminants,
- The means of securing containment of these substances and their likelihood of being released into the environment, and
- The pollution prevention measures employed by the land uses or activities, among other things.

Certain land uses characteristically use larger amounts of potential contaminants or particularly toxic substances. The geographic extent and intensity of land uses also influence the degree of the threat.

The geographic location of these land uses over the aquifer also determines the degree of threat. While all uses over an unconfined aquifer pose some degree of hazard because of the potential for all substances to migrate to groundwater, some locations are more sensitive than others. Well capture zones, or those areas where rain falling on the land surface eventually finds it s way to a particular well, are highly sensitive. The capture zones of community wells are significantly more important than those of private wells simply because of the number of users involved.

The areas immediately surrounding a well, called wellheads, are even more sensitive. As opposed to taking possibly years for a contaminant in a well capture zone to migrate from the earth's surface to a particular well, contaminants released at a well-head which has no protection measures could cause almost immediate contamination of the well-water.

Additionally sensitive areas are those that are found upgradient of, and contribute to the recharge of, surface water courses.

A study conducted by Royal Roads University in 1998 attempted to identify the higher risk urban non-agricultural land uses (essentially industrial and service commercial activities) over the aquifer. Its results for different types of land uses were somewhat inconclusive because of varying industrial and other operational practices. In effect, the degree of risk was more directly associated with the observed management practices than the type of activity. It points to management practices as an intended target for intervention than to the placement or location of land use activities themselves.

GROUNDWATER QUANTITY

Groundwater Quantity Trends

Currently, there is scant information available on the total volume of water being extracted by non-municipal wells from the aquifer. Information from community wells and Provincial facilities, such as the Trout Hatchery, does exist; but, private residential, agricultural and industrial wells are not currently required to report their withdrawal rates to any authority. The Provincial data base has both partial and very outdated information. A ground water budget formulated in 1992 determined that total withdrawals (420L/sec) and discharges to springs and underflows (470 L/sec) exceeded minimum annual recharge (850L/sec); but were less than half of estimated maximum recharge (1850L/sec).

Nonetheless, with continuing development over the aquifer, in terms of rural residential, intensive and other farming, and industrial activity, especially in the Clearbrook-Peardonville area of Abbotsford (CICP lands), it is reasonable to assume that withdrawal rates have increased since 1992. In fact, continually increasing demand will at some point in time approach, or possibly exceed, natural recharge placing the aquifer water balance in a negative situation. This would mean that continued withdrawal would eventually deplete the aquifer. Fortunately, current data from monitoring wells do not show a trend of unsustainable drawdown, although localized aquifer drawdown effects can be seen in summer months in areas of active groundwater pumping.

There is currently little to no information on what groundwater levels are needed to maintain base flow in streams above the aquifer. Furthermore, there is also scant information on the potential impact of climate change on groundwater recharge and groundwater balance.

As a result of the City of Abbotsford undertaking an Environmental Assessment for its proposed Bevan Avenue wells, some data has been generated on the extraction rates north of the Trans-Canada Highway.

Threats to Water Quantity/Supply

The primary threat to those that depend on groundwater for a range of uses is the possibility of over-extraction or mining of groundwater. Groundwater mining occurs when the amount of groundwater withdrawn by wells exceeds the amount of water that naturally recharges the aquifer through precipitation and upsets the balance between water going into the aquifer and groundwater naturally discharging from the aquifer to surface water bodies. As a result, the actual amount of groundwater in the aquifer (effectively a volume in storage) decreases over time and is seen as a drop in the depth of the water table below ground surface. The water table can drop below the depths of the wells, causing wells to dry up.

Currently, there is only minimal regulation to ensure the sustainability of groundwater supply for existing or future wells and future uses and for maintaining healthy baseflow conditions to streams (where groundwater from the aquifer discharges to surface water). Individual wells typically create a localized depression in the water table around them when pumped and this effect can impact the performance of other nearby wells (an effect known as well interference). Currently, new wells (below the BC Environmental Assessment Act threshold capacity of 75 litres/second) can be drilled without having to determine potential impacts on existing neighbouring wells or nearby surface watercourses. Even existing wells can also theoretically increase their withdrawal rates without considering these impacts.

Widespread extraction of groundwater at rates in excess of the sustainable yield of the aquifer (cumulatively exceedance of the recharge) can create an over-extraction or groundwater mining situation. Climate change could also conceivably alter precipitation patterns and aquifer storage volumes significantly through changes to the normal recharge rate of the aquifer. Even without significant increases in groundwater withdrawal rates, it is possible that with decreased rainfall, possibly as a result of climate change, or with an altered rainfall regime, recharge in the future might not be enough for maintaining a water balance. Climate change can also result in longer dry seasons (*e.g.*, summer), longer crop growing seasons and greater demand for water.

In developed areas, there is an inherent competition for groundwater between domestic water needs (gained from wells) and ecological needs (maintaining stream base flows). Both currently and in the future, groundwater extracted for drinking water, irrigation or livestock watering and industrial-type process purposes has the ever-present potential to reduce groundwater levels to where they can no longer recharge surface waters. Under such conditions, continued increases in extraction would exacerbate impacts to surface water bodies and could result in Federal government action under the Canada Fisheries Act.

Increases in impervious surface area from urban development (residential, commercial and industrial) and certain types of agricultural operations, such as intensive livestock barns, greenhouses and mushroom growing barns, could direct more water to surface watercourses (via storm drainage or direct runoff) and reduce the amount of water that could infiltrate as groundwater recharge to the aquifer.

Prioritization of Threats

Major threats to the availability or supply of groundwater include:

- Increased consumption or production from existing wells without regard for impacts on neighbouring wells
- Additional consumption from newly drilled or proposed wells
- Altered water balance where new extraction rates exceed normal recharge
- Altered groundwater recharge due to the effects of climate change
- Continued growth of high volume water-consuming industries or agricultural operations (food processing, intensive livestock)

APPENDIX B

Case Studies:
Township of Langley, BC
Bow River Basin Council, Alberta
Oxford County, Ontario
Regional Municipality of Waterloo, Ontario
Rathdrum Prairie Aquifer, Washington and Idaho
Southern Williamette Valley, Oregon
Dayton, Ohio

April 12, 2012
Report No. 10-1435-0013

Golder Associates

BACKGROUND AND CONTEXT

i) Case Study Title:

- Township of Langley Water Management Plan

ii) **Location:**

- Township of Langley, BC

iii) Land Use Characteristics:

- The Township of Langley serves a population of approximately 100,000 which is expected to grow to 165,000 by the year 2021.
- The Township is characterized by both urban and rural land use, with a mix of agricultural, commercial, industrial and residential land use. About 75% of the Township is in the Agricultural Land Reserve.

iv) Issues of concern/trigger for plan:

- The Water Management Plan was initiated to address concerns related to the groundwater supply and groundwater quality. Water balance analysis indicates that the current level of groundwater withdrawals are resulting in reduced baseflows to local streams. With respect to groundwater quality, elevated nitrate levels have been detected in groundwater in some areas, indicating that groundwater is vulnerable to contamination from septic systems and agriculture land use practices.

v) Hydrogeological setting:

- Eighteen aquifers have been delineated within the Township boundaries, some of which are shallow and unconfined. There are also 14 watersheds, most of which are recharged by groundwater and support economically important stocks of wild salmon and trout.

vi) Groundwater Use:

- Approximately 80% of residents rely on municipal water supply. About half of the municipal supply is derived from municipal water wells and the remainder is derived from the Metro Vancouver Water District. In addition, there are some 5000 private water wells. Groundwater represents a source of water for residential, agricultural, industrial and commercial users.

GROUND WATER PROTECTION MECHANISMS

The Township of Langley (TOL) Water Management Plan (WMP) was developed under the BC Water Act and represents the first of its kind in BC (Final report, November 2009). It has yet to be ratified by the province; we understand that the province is reviewing the WMP to identify priority actions, explore funding mechanisms and define the scope of the WMP implementation in the context of the new Water Sustainability Act. Provisions for voluntary and regulatory mechanisms proposed by the WMP are outlined below. The plan calls for these mechanisms to be implemented by the Township of Langley and by provincial agencies.

i) Volunteer Mechanisms:

- Initiate a pilot Nutrient Management Plan (NMP) in the Hopington area (MAL/MOE/TOL);
- Collaborate with BC Agriculture Council and MAL to enhance local participation in the Environmental Farm Program (MAL/MOE/TOL);
- Promote eco-friendly alternatives to emergency response chemicals (e.g., fire retardants) (MOE/TOL);
- Fund and implement a comprehensive monitoring and study program to inform future groundwater decisions (MOE/TOL);
- Enhance public awareness, education and incentives (MAL/MOE/TOL);
- Review the WMP in Year 5 and provide interim progress reports.

ii) Regulatory Mechanisms:

a. Provincial Regulatory Environment:

- Mandate drilling authorizations for new or altered water supply wells (MOE)
- Develop an integrated system for issuing drilling authorizations and surface water levels (MOE)
- Review water supply and licensing on fish bearing streams within the Township (MOE)
- Identify flowing artesian wells and make sure they are stopped or brought under control (MOE)
- Mandate the prohibition of new groundwater bottling operations through legislation (MOE, TOL)
- Ensure specified provincial statutory decision makers consider the WMP in making their decisions (MOE)
- Adopt a series of locally enforceable agricultural practices in the TOL (MAL/MOE/TOL)
- Eliminate the exemption in the Water Act that allows persons who are not qualified well drillers to undertake certain activities (MOE)
- Require proper closure of an unused well within a time period that is allowed under the GWPR (MOE)
- Require all contaminated sites be remediated to soil and groundwater standards for the protection of drinking water (MOE)
- Support the provincial government to ensure local compliance with contaminated site regulations (MOE, TOL)
- Collaborate with real estate sector to ensure GWPR requirements are met during property Acquisition (MOE)
- Restrict the production, use, storage and/or disposal of high risk contaminants in areas above highly vulnerable aquifers and/or within municipal well capture zones (MOE/TOL)

- Coordinate abandoned well closure through a mandatory registry program (MOE)
- Mandate submission of new and existing well data to provincial WELLS database (MOE)
- Establish a funding mechanism for approved WMPs under part 4 of the Water Act (MOE)
- Establish a local (environmental) protection officer (MOE/TOL)
- Review EMA and the water Act to identify offenses that are appropriate for ticketing ans take steps to make them ticketable (MOE)
- Investigate more rigorous inspection and enforcement of existing regulations affecting groundwater quality (MOE)

b. Local Regulatory Environment (Township of Langley):

- Enhance municipal planning and development initiatives
- Enhance water supply system
- Mandate summertime lawn sprinkling restrictions for private well owners (MOE, TOL)
- Implement a management plan for decentralized sewage in the TOL
- Undertake source water assessments of municipal wells within the Township working in conjunction with local Drinking Water Officer (TOL)

MANAGEMENT FRAMEWORK

i) Type of Water Management Body (or Bodies):

- An Interagency Planning Team was established to develop the Water Management Plan.

ii) Mandate of Water Management Body:

a. Vision, goals, objectives, principles of operation:

- The mandate of the Interagency Planning Team was to develop the Water Management Plan. The project charter is available on the project website. Decision-making was consensus-based, with the support of a professional facilitator.

b. Formal allocation of authority: from the province

c. Existence and form of a strategic plan of action: NA

d. Procedural rules: NA

iii) Geographical Boundary of Responsibility of Water Management Body:

- Township of Langley boundaries

iv) Time Period of the Mandate of the Water Management Body:

- The Interagency Planning Team was formed to develop the Water Management Plan and is no longer in place. No formal management structure for the implementation of the Water Management Plan has been established.

v) Key Participants and Roles/Responsibilities of Management Body:

- The Interagency Planning Team was comprised of representatives from the Township of Langley, the Ministry of Environment (MOE) and the Ministry of Agriculture and Lands (MAL). Their role was to develop the WMP.
- Input for the development of the WMP was obtained from a Stakeholder Advisory Committee (SAC) comprised of 13 representatives (invited participants).
- A technical workshop was held with 12 local and regional groundwater experts to gain input.

vi) Delegation and Decision-making Processes:

- Decision-making was consensus-based, with the support of a professional facilitator.
- Public consultation was obtained through two public open houses, meetings with community groups, a telephone survey, feedback forms and email submissions.

vii) Mechanisms to Support Transparency, Accountability and Enforcement:

FINANCIAL FRAMEWORK

Required funding for the implementation of the WMP is estimated to be 1 Million dollars per year. The funding mechanism for the program has not been identified. Representatives indicated that the intent was for the province and the Township to share in the funding.

DATA COLLECTION MECHANISMS

Some of the outstanding data requirements are outlined in the proposed protection mechanisms.

LESSONS LEARNED

The Township of Langley was selected by the province to be the pilot community for the development of a Water Management Plan based on the challenges the community was facing and the initiatives they had undertaken towards groundwater management.

Considerable staff commitment (follow-through) is required, together with the buy-in of local political representatives. Workshops conducted for the Mayor and Council helped to raise their awareness of and support for the issues.

Provincial support of local government is required to allow the implementation of a full range of control measures.

A champion or "driving-force" is required to ensure the success of the program.

Use of a professional facilitator proved to be a valuable way of achieving consensus during the development of the WMP.

Representatives for the Stakeholder Advisory Committee were invited to participate. In hindsight, representatives stated that to avoid a perception of bias, an initial public call for stakeholders should have been made and if a sufficient response was not obtained, then invitations could have been extended to particular individuals. Representatives stressed that the consultation process should begin at the early stage of the project.

Representatives indicated that given the complexity of the local hydrogeology, it was easier to develop the plan in accordance with municipal boundaries, rather than aquifer boundaries.

Considerable opposition to water metering was encountered during the development of the plan and dominated much of the consultation process. While this was unfortunate, it did allow the team to incorporate other elements into the plan that otherwise may have been contested.

STUDY DETAILS

i) **Case Study Representative:**

Antigone Dixon-Warren

ii) **Affiliation and Contact Information:**

Formerly with the Township of Langley, now with the Corporation of Delta (604-946-3343)

iii) **Golder Interviewer:** Jill Sacre

iv) Interview Date: February 25, 2011

v) Reference Material:

Interagency Planning Team, November 2009. Township of Langley Water Management Plan, Final Report.

Golder Associates Ltd., June 2005. Comprehensive Groundwater Modelling Assignment. Final Report.

BACKGROUND AND CONTEXT

i) Case Study Title:

- Bow River Basin Council

ii) Location:

- Alberta, Canada

iii) Land Use Characteristics:

- Approximately 1.2 million people live in the Bow River basin, with population density of approximately 41 people per square kilometre in the most populated areas.
- Over the last 10 years, population has increased by more than a quarter million.
- The current population is 95% urban (22 urban municipalities, including the City of Calgary) with 4% residing in 12 rural or regional municipalities, and less than 1% residing in Aboriginal settlements.
- There are 13 dams, 4 weirs, and 8 reservoirs on the Bow River.
- Water usage includes hydroelectric generation, effluent dilution, and water allocation for irrigation, municipal, industrial, agricultural, and recreational uses. 76% of allocated water is licence for irrigation.

iv) Issues of concern/trigger for plan:

- Stormwater runoff and wastewater effluent are a concern. Population growth has placed additional demands on the water supply and will likely become a greater challenge in the future. Climate change and glacial retreat add uncertainty to the quantity of flows for the future.

v) Hydrogeological setting:

- Groundwater will be the focus of Phase II, which is scheduled for 2012.

vi) Groundwater Use:

- Groundwater will be the focus of Phase II, which is scheduled for 2012.

GROUND WATER PROTECTION MECHANISMS

i) Volunteer Mechanisms:

- Not yet developed.

ii) Regulatory Mechanisms:

- Not yet developed. See section on Local Regulatory Environment.

iii) Regulatory Framework:

a) Provincial Regulatory Environment

- **Environmental Protection and Enhancement Act** – regulates drilling of wells and groundwater protection.
- **Policy for Utilizing Groundwater for Geothermal Purposes (2007)** - Sets the regulatory approach for assessing applications to use groundwater for geothermal heating and cooling and identifies under what conditions Approval would be required. It identifies that applications must include information on the capability of aquifers to circulate the required quantities of groundwater and to consider the effects on the groundwater quantity, temperature and quality, as well as the effects on other water users.
- **Policy on Water Diversions from Sand and Gravels Adjacent to a Water Body and from Springs (2003)** - Sets out under what process applications will be evaluated. All projects in sand and gravel deposits adjacent to a water body (river, stream, lake, etc.) will be evaluated according to licensing and approval requirements of surface water works and diversions. All applications for diversion from springs will be evaluated using procedures for surface water issues. The Groundwater Evaluation Guideline will be needed for all applications where there is no hydraulic connection to a surface water source and where effects of groundwater diversion on local ground water users may be significant. The Groundwater Evaluation Guideline will also be used where the development of a spring will increase the groundwater flow rate.

b) Local Regulatory Environment

- The BRBC identified the local bylaws as a gap in the regulatory environment as current bylaws do not allow for enforcement of protection. The BRBC provided draft bylaw language to local municipalities for their consideration.

c) Best Management Guidelines

- **Groundwater Evaluation Guideline (2003) (Alberta Government)** - Provides a guideline for the use and management of groundwater and identifies evaluation criteria, best management practices, and background on the legislative framework for regulating the use of groundwater.

MANAGEMENT FRAMEWORK

i) Type of Water Management Body (or Bodies)

- The BRBC is a complex system of committees with an overarching membership that is broken down to specific sub-committees. The BRBC is a Watershed Planning and Advisory Council (WPAC), a recognised program developed by the Government of Alberta through their *Water for Life* sustainability action plan.

ii) Mandate of Water Management Body:

a) Mission and Purpose:

- The Bow River Basin Council (BRBC) is a multi-stakeholder, charitable organization dedicated to conducting activities for the improvement and protection of the waters of the Bow River Basin, considering:
  - riparian zones;
  - aquatic ecosystems;
  - quality and quantity of water, and,
  - effects of land use on surface and groundwater.
- In the Bow River Basin, the BRBC will:
  - Maintain a forum for all Council members to share perspectives and exchange information;
  - Prioritize water use management issues in the basin that may affect the quality and/or quantity of groundwater or surface water or riparian zones;
  - Participate in water use management and planning activities;
  - Develop and recommend improved water use management procedures and performance measures;
  - Encourage the implementation of cooperative water use management strategies;
  - Participate in activities that promote and demonstrate increased awareness of water use management issues to its members, the governments of Alberta and Canada, and the public;
  - Conduct and direct fundraising for the BRBC;
  - Obtain and use assets and funds entrusted to the BRBC for benevolent, cultural, ecological, educational, planning and/or recreational purposes for the improvement and protection of the Bow River Basin (Alberta) watershed; and,
  - Review and decide upon requests for funds and/or resources from the Council and others on the basis of the merits of the requests, availability of funds, and sound financial and project management principles.
- Project Phases and Timeline:
  - On-Line State of Watershed Report and Summary Booklet (2009-ongoing);
  - Phase Two: Land Use within the Entire Bow Basin, Headwaters, Wetlands and Riparian Areas (2010-2011);
  - Phase Three: Surface and Groundwater Quantity (2012-2013); and,
  - Phase Four: Surface Water Quality Revisited and Groundwater Quality (2014-2015).

b) Formal allocation of authority:

- The BRBC is recognised by the Alberta Provincial Government as the WPAC for the Bow Basin.

c) Existence and form of a strategic plan of action:

- Draft Terms of Reference published in September 2010.

d) Procedural rules:

- The BRBC is governed by the requirements of the Water for Life program as a recognised WPAC. The Province will be releasing the *Alberta Water Council's Shared Governance Framework for Water for Life Partnerships* to guide member organizations in the near future.
- The BRBC does not take a regulatory approach, as the focus is on objectives, not how you reach them.

iii) Geographical Boundary of Responsibility of Water Management Body:

- Hydrogeologic (capture zone, aquifer or watershed based) versus political or other: Watershed/basin.

iv) Time Period of the Mandate of the Water Management Body:

- Not specified.

v) Key Participants and Roles/Responsibilities of Management Body:

- The **Bow River Basin Council** (BRBC) is a multi-stakeholder, charitable organization. Membership is free, but participants must register under one of the following categories: Commercial/Industrial, Individual Public Members, Licensees, Municipal Government, Non-profit/Academia, or Regulatory/Administrative/First Nations.
- The **Board of Directors** is made up of members representing each of the categories and provide high level direction and specific input to the Bow Basin Water Management Plan (BBWMP). Members report back to the BRBC.
- The **BBWMP Steering Committee** oversees the development of the BBWMP, reports to the Board of Directors.
- The **BBWMP Monitoring and Modeling Committee** is the technical committee who develops and reviews the recommendations.
- The **BRBC Legislation and Policy Committee** coordinates the two-day planning workshop.
- The **BRBC Education and Communications Committee** coordinates public engagement and communications.
- The **BRBC Fundraising Committee** solicits funds to support the projects.
- The **Industry, Agencies, Landowners, Non-Profit Organization, First Nations and Government (Federal, Provincial, and Municipal) Partners** provide technical support, input and endorsement of the BBWMP and provide funding, where possible.

vi) Delegation and Decision-making Processes:

- The Bow River Basin Council is recognised by the Alberta Provincial Government as the Watershed Planning and Advisory Council (WPAC) for the Bow Basin.
- The BRBC can have input into and recommend policy and initiatives, but it is up to the Alberta Provincial Government to approve and implement policy. This process is defined as part of *Water for Life: Alberta's Strategy for Sustainability* and is the relationship between the different WPAC's and the Province is defined in *Enabling Partnerships: a framework in support of Water for Life: Alberta's Strategy for Sustainability.*
- Public involvement is required by the Water for Life program and the Education and Communications Committee is responsible for coordinating and undertaking public engagement and education.

vii) Mechanisms to Support Transparency, Accountability and Enforcement:

- Monitoring and auditing mechanisms and key incentives for good performance were not readily available online.
- To aid in the support of compliance with legal requirements, the BRBC Legislation and Policy Standing Committee is mandated to consider and recommend applicable municipal, provincial and federal water legislation and policy to the Board of Directors. In 2006, the draft *Template of Land Use Bylaw Provisions to Protect Water Resources, Wetlands, Riparian Lands and Reserve Lands within Alberta Municipalities* was circulated to municipalities open for comment for two years. The committee identified a gap in the local municipalities Municipal Development Plan (MDP) policies and provided draft language that could be incorporated into MDP to allow for Land Use Bylaw Regulations developed by the BRBC to be recognised.

FINANCIAL FRAMEWORK

In 2009, 73.5% of funding came from members. This includes grants from Alberta Environment and funding from municipal governments as they are member of the BRBC. Federal funding was available in the past, but not in 2009.

The BRBC Annual report includes a summary of finances, including where funding is received and where expenditures were made.

The BRBC also provides grants to non-profit organizations for improvement projects focusing on ecological, cultural and recreational objectives. Projects are required to include public participation and result in a measurable improvement in the Bow River Basin. The funding maximum is $10,000 and funding is capped 50% of the proposed budget. Funding must be matched by the applicants. Funding recipients must also provide quarterly financial reporting that identifies the progress and funds being utilized.

Expenditure management process is not readily available online.

DATA COLLECTION MECHANISMS

The Technical Committee provides technical input to discussion making, but is at a review level, not data collection. The BRBC funds data collection projects.

LESSONS LEARNED

When the program was first initiated, a survey was sent to all of the stakeholders soliciting their ideas and concerns. The survey was not a useful tool. A consultant was hired to lead the issues identification and instead sent out a short answer questionnaire and led a stakeholder engagement session based on the results. It was more expensive but worth the cost as it engaged the stakeholders in a positive way to start the program with much better results than the original written survey.

Calgary has taken a strategic approach to stakeholder engagement rather than open public consultation. They are always open to involving new community members, but do not directly solicit input from the greater community.

First Nations consultation has been challenging as there has been no support from the government to engage at the level the First Nations expect.

Land use continues to be contentious. Calgary and the surrounding region is working on a regional land use plan which has become quite contentious and led to fears that land rights will be lost. New legislation is under development to address cumulative effects. It is not yet clear what the legislation will mean in practice.

The BRBC has challenges obtaining GIS data they can manipulate for mapping. GIS mapping data is protected differently in Alberta. Through discussion, it sounds as though this should not be as limiting in BC.

STUDY DETAILS

i) **Case Study Representative:** Mike Murray, Program Manager, Bow River Basin Council

ii) **Affiliation and Contact Information:** City of Calgary Water Office, 403-268-4597, mike.murray@calgary.com

iii) **Golder Interviewer:** Allison Takasaki

iv) **Interview Date:** March 2, 2011

v) **Reference Material:**

Bow Basin Watershed Management Plan – Phase Two, September 16, 2010 - Draft BBWMP Terms of Reference.

Enabling Partnerships: a framework in support of Water for Life: Alberta's Strategy for Sustainability. No date provided.

Water for Life: A Renewal, November 2008.

http://www.brbc.ab.ca

BACKGROUND AND CONTEXT

i) **Case Study Title:**

- County of Oxford, Ontario

ii) **Location:**

- Oxford County is in southwestern Ontario and is comprised of eight area municipal governments: Township of Blandford-Blenheim, Township of East Zorra-Tavistock, Town of Ingersoll, Township of Norwich, Township of South-west Oxford, Town of Tillsonburg, City of Woodstock, and Township of Zorra.

iii) Land Use Characteristics:

- Oxford County is characterized by rural and agricultural land use, with a population of 100,000. In addition to agricultural land use, local activities include aggregate extraction, manufacturing (mainly automotive, construction, small businesses and highway maintenance.

iv) Issues of concern/trigger for plan:

- The trigger for the plan, which was initiated in 1997 (before Walkerton), was an application for an intensive hog farming operation which generated considerable public opposition. This occurred just after the University of Waterloo published a study on nitrates, which attributed much of the nitrate in the local groundwater to farming activities (rather than septic systems). In response to these concerns, the County passed an Interim Control Bylaw to prohibit the establishment of new livestock operations over 500 livestock units in size.

v) Hydrogeological setting:

- Oxford County is characterized by glacial deposits. These include extensive till plains, consisting of low-permeability silts and clays which are generally poor suppliers of water, but which act to protect underlying granular or bedrock aquifers. Glacio-fluvial spillway deposits cross the area and are typically course-grained, permeable sands and gravels which yield good water supplies, although they are particularly vulnerable to impacts from land use activities. A major deposit of glaciolactustrine sands known as the Norfolk Sand Plain extends across the southeastern corner of the County. This deposit forms an important aquifer, although it is very vulnerable.

vi) Groundwater Use:

- Almost all of the County's water supply is derived from groundwater sources, with a very minor amount of surface water used in the south part of the County for irrigation. Of the 100,000 residents, approximately 70,000 are supplied by municipal water systems (comprised of 83 municipal wells) and 30,000 are supplied by private wells.

GROUND WATER PROTECTION MECHANISMS

i) Volunteer Mechanisms:

- Concerns related to private water wells were addressed through incentive programs. For example, technical assistance and financial incentives were provided to improve and protect water quality on farms and in rural areas through the Clean Water project.
- The County of Oxford purchased a number of farms in the two-year time-of-travel zone of Woodstock's Thorton Well Field to control land use activities in those areas.
- A children's groundwater festival was held to educate elementary school children on water conservation, water protection, technology and ecology.
- A "Map your Farm" application is available on the County's website to provide public access to a range of land and water use related information.

ii) Regulatory Mechanisms:

- A Nutrient Management bylaw was initially developed by the County under Ontario's Municipal and Planning Acts. This served as a model for the eventual development of the Nutrient Management Act by the province. Once the provincial legislation was developed, the County repealed their bylaw and replaced it to ensure consistency with the new provincial act.
- The County has amended its Official Plan to include land use policies for water protection and conservation. The plan will be finalized when the provincial Source Water Protection regulations have been finalized.
- Land use controls will only be implemented for new land use; control of existing land use requires a risk-based approach under the provincial Source Water Protection Act, which requires that a significant threat to groundwater quality be demonstrated.
- A salt management plan was undertaken by the County under the salt toxicity requirements of Environment Canada.

MANAGEMENT FRAMEWORK

i) Type of Water Management Body (or Bodies):

- The planning process was led by the County of Oxford. However, a "level playing field" approach was used to gain the support of the five area governments in the process. The program was developed through a collaboration of Planning representatives, the Board of Health and Public Works. Provincial ministry representatives provided technical expertise.
- Input into the development of the plan was obtained from two Committees:
  - A Nutrient Management Committee, which evolved into the Agricultural Advisory Committee.
  - Water Protection Committee.

ii) Mandate of Water Management Body:

- The mandate of the Nutrient Management committee was to study issues related to large livestock operations and recommend a strategy to address such issues.
- The mandate of the Water Protection Committee was to develop a strategy to protect groundwater resources.

iii) Geographical Boundary of Responsibility of Water Management Body:

- County of Oxford.

iv) Time Period of the Mandate of the Water Management Body:

- The Nutrient Management Committee operated for a two-year period.

v) Key Participants and Roles/Responsibilities of Management Body:

- The Nutrient Management Committee was comprised of representatives of the major livestock commodity groups, together with local and County councillors, with staff support from the County, the Township of East Zorra-Tavistock, and the Ontario Ministry of Agriculture and Food.
- The Water Protection Committee was comprised of 35 members from local industry (including agriculture), together with staff and councillors from the area municipalities and the County.

vi) Delegation and Decision-making Processes:

- Decisions of the Water Protection Committee were made by a show of hands.

vii) Mechanisms to Support Transparency, Accountability and Enforcement:

- A considerable investment was made to educate the group concerning the issues. A land-use planning expert was used to provide an opinion on case law with respect to land use control.

FINANCIAL FRAMEWORK

Funding for the Phase I groundwater protection study ($40,000) was provided by the County of Oxford. The province of Ontario provided much of the funding for the Phase II study, together with vulnerability mapping (estimated to be on the order of $850,000). Ongoing funding, including a reserve fund for land acquisition, has been established from water rates. Initially, these rates were based on a flat water rate because metering was not in place.

The County has 1 ½ staff dedicated to the program, together with a hydrogeologist on retainer.

DATA COLLECTION MECHANISMS

Technical data required for the development of the plan was obtained through Phase I and Phase II groundwater protection studies and a vulnerability mapping study.

A number of studies have been carried out in cooperation with the University of Waterloo, including studies related to aquifer modelling, geochemistry and nitrate occurrence.

A pilot land use and chemical occurrence (LUCO) inventory is being undertaken to identify past and present sources of potential contamination.

Groundwater quality monitoring is undertaken by the province at 10 locations in the County as part of the provincial groundwater monitoring network. The Oxford County also promotes the rural Water Quality Testing Program, administered by the Ontario Federation of Agriculture for the Ontario Farm Coalition.

LESSONS LEARNED

County representatives reported that a "peer-to-peer" process was the most effective way of engaging stakeholders, particularly the farming community.

Strong provincial support, including regulation and funding, was required to ensure the success of the program.

County representatives reported that obtaining a legal opinion on land control options was highly beneficial to the planning process.

County representatives advised that it is beneficial to build alliances with other jurisdictions facing similar issues to lobby for support at the provincial level. Technical programs should be advanced in parallel with political lobbying.

STUDY DETAILS

i) Case Study Representative: Margaret Misek-Evans

ii) **Affiliation and Contact Information:** Formerly a planner with the County of Oxford, now with the Capital Regional District (250-360-3244)

iii) **Golder Interviewer:** Jill Sacré

iv) Interview Date: February 22, 2011

v) Reference Material:

Golder Associates Ltd., 1999. Groundwater Protection Study Phase I, County of Oxford.

Golder Associates Ltd., 2001. Groundwater Protection Study Phase II. County of Oxford.

Environment Canada, 2004. Case Study – Oxford County: http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=F33CB10C-1

BACKGROUND AND CONTEXT

i) Case Study Title:

- Regional Municipality of Waterloo

ii) Location:

- Waterloo, Ontario

iii) Land Use Characteristics:

- Residential, agricultural, business/industrial

iv) Issues of concern/trigger for plan:

- In 1989, the MOE detected nitrosodimethylamine (NDMA), an industrial organic chemical, in several drinking-water wells in Elmira during routine analysis of the drinking-water system. The wells were shut down and steps were taken to being groundwater protection programs. After the inquiry into the Walkerton contamination, watershed based approach to source water protection became a priority of the Ontario Ministry of Environment (MOE).

v) Hydrogeological setting:

- Most groundwater abstracted in the Cambridge area is derived from Paleozoic carbonate bedrock, while most groundwater abstracted in the Kitchener-waterloo area is derived from a complex series of Pleistocene outwash sands and gravels inter-layered between dense, glacial till.

vi) Groundwater Use:

- Water supply for Regional Municipality of Waterloo and surrounding region. Approximately 75% of the water supply is provided by groundwater; the remaining 25% is provided by surface water from the Grand River.

GROUND WATER PROTECTION MECHANISMS

i) Volunteer Mechanisms:

- There is a program to engage farmers in reducing nitrate risks and a program to limit risks from road salt application. Formal stakeholder engagement on groundwater policy has not yet taken place.

ii) Regulatory Mechanisms:

- Water Resource Protection is integrated into the Regional Municipality of Waterloo planning and regulatory processes and works within MOE requirements for source water protection.

iii) Regulatory Framework:

a) Provincial (or US State) Regulatory Environment (Ontario Ministry of Environment):

- **Safe Drinking Water Act (2002)** - Introduced *Groundwater Under the Direct Influence* of (GUDI) Surface Water as a category of municipal wells. GUDI were considered more vulnerable to microbial and pathogenic contamination. Protection of source water from microbial/pathogenic contamination became a high priority of the MOE who emphasised the need for protection from this threat. Waterloo is currently implementing programs to control microbial contamination of GUDI wells.
- **Spill Prevention and Contingency Plan (2007) -** Identifies and assesses all aspects which could potentially contaminate the surrounding environment and water supplies as well as the appropriate procedures for handling, storage and cleanup of materials and areas or processes in which spills may potentially occur.
- **Clean Water Act (2007) -** Identifies a watershed-based approach to development of the Source Protection Plans (SPP) and provides governance structures, including:
  - Watershed grouped into regions comprised of two or more watersheds to develop SPPs and facilitate the sharing of resources, expertise. Waterloo falls into the the Lake Erie Region which comprises the Grand River, Long Point, Catfish, and Kettle Creek watersheds.
  - Establishment of Source Protection Board (SPB) for each watershed to coordinate/review the work of a multi-stakeholder Source Protection Committee (SPC) and recommend the SPP to the MOE for approval.
  - The SPC will coordinate development of a Terms of Reference that will specify the process for completing a number of technical assessments, the draft SPP, and local consultation process.

b) Local Regulatory Environment:

- **WRPS Implementation Plan (1994)** - Approved by the Waterloo Regional Council in 1994, the WRPS Implementation Plan is a ten-year program for groundwater and surface water management activities to limit the risk to water resources from historic or existing land-use practices, and minimize the risk from future land use. The implementation plan divided the projects and activities, including data management and monitoring required providing the framework necessary for developing effective protection programs. Staff has since identified following steps were necessary to adequately express the scope of activities needed to protect water supply:
  - Understanding and mapping sensitive areas contributing water to the municipal system.
  - Identifying and mapping potential sources of contamination in the supply.
  - Developing and implementing policies and programs to manage land uses and activities.
  - Building awareness and educating the public about their water supplies.

- **Groundwater Protection Policy Options Discussion Paper (1995) -** This paper outlined potential sources of groundwater contamination, possible options for dealing with each type of problem, and provided an initial evaluation of advantages and disadvantages of each option. The document informed discussion of groundwater protection options. Priority was given to address sources of contamination with the highest potential for contamination and toward sources that could be most easily addressed using the Region's current authority. The three highest priority source types were:
  - Rural non-point sources (runoff/infiltration of nutrients from agricultural operations).
  - Current urban point sources (spills/discharges from industrial/commercial operations).
  - Future urban point sources (new industrial/commercial operations proposed in urban areas).

  Road de-icing operations were later added to the list as levels of sodium and chloride observed in supply wells increased.
- **Groundwater Protection Areas Policy Discussion Paper (1996)** - This paper provided recommended the delineation of groundwater protection areas, including "well head protection areas" to be delineated based on groundwater times of travel in the aquifer (two year and ten year) and "aquifer recharge protection areas" which would be delineated based on mapping of large-scale regional recharge features. The implementation of the strategy has focused on the development of programs and policies to protect the resource. Specifically, the following programs were designed to address the priority concern areas in municipal water supplies:
  - The Rural Water Quality Program, 1998, provides financial incentives to farmers to upgrade and implement Beneficial Management Practices to reduce risk of contamination. The program is delivered by the GRCA and to date almost $3 million has been provided in incentives through this program.
  - Winter Road Maintenance Policy and Procedures, 2003, created consistent standards for maintaining roads in the Region Water Resources Protection Master Plan and provided a mechanism to introduce new training and equipment upgrades for reducing the impact of road salt. The Regional and area municipality road departments have been implementing measures to reduce the use of salt, including changing snow pile locations, installing snow fencing, adjusting salting based on temperature. The department is now addressing private parking lot and sidewalk de-icing activities and developing of salt impact assessment guidelines for development applications. The "Smart about Salt" certification program was established for snow contractors, companies, institutions and industry to improve awareness of salt concerns and how to improve practices and the "Snow Clearing Guide" was established for residential use.
  - Regional Official Policy Plan in 2000 (Amendment No. 12) established well head protection sensitivity areas around each municipal supply well and created restrictions on new non-residential development in these areas. The amendment also include a pilot program for a Development Permit System which was discontinued in 2004 as several changes in the

legislation were necessary to facilitate the use of this system for groundwater protection. More recent initiatives include integration of policies and protection mechanisms identified through studies into the official planning documents, including the Official Community Plan.

- The Business Water Quality Program, 2001-2005, provided incentives for businesses to reduce the potential of spills to surface water, groundwater and sanitary sewers. In partnership with the Ministry of Environment, this program was designed to address the potential impacts from existing businesses handling hazardous chemicals and review and clean up contaminated sites. The BWQP was terminated in December 2005 primarily due to the high administration to grant funding ratio.

At the regional/municipal level, the Regional Official Plan was recently approved. The Land Use section prohibits certain land uses in protection areas, including use of salt and aggregate. Currently, policies are only in place for future developments however, the Region is developing policies to address current land uses. Through the Clean Water Act, threat assessments have been undertaken through self reporting and existing studies. To date, 200+ threats have been identified. Waterloo is working with other municipalities to determine how policies can be used to address existing threats. Currently being considered are risk management, restrictive land use, including site specific restrictions that will not require changes in zoning, and prohibition. Other policy tools include land use planning, incentives, education and outreach, and best management practices.

MANAGEMENT FRAMEWORK

i) Type of Water Management Body (or Bodies):

- The programs interact with three levels of authority, the Province which is mandating protection measures and source water protection plans, the Groundwater Conservation Authority which implements programming, and the municipality which makes the local level policy to implement groundwater protection programs. Groundwater Conservation Authority's are regional agencies that are arm's length government program delineated by watershed. The local authority in Waterloo is the Grand River Conservation Authority (GRCA). The GRCA is involved stewardship programs and works closely with agricultural community.

ii) Mandate of Water Management Body: No management body, programs administers at three levels.

a) Vision, goals, objectives, principles of operation:

n/a

b) Formal allocation of authority (*e.g.,* from province):

Province, Groundwater Authority, Municipal

c) Existence and form of a strategic plan of action:

Water Resource Protection Master Plan (2008)

d) Procedural rules:

Municipal Land Use plans prohibit certain new activities and developments in protected areas. New Bylaws are being considered to control land use and implement protection measures on existing land use.

iii) Geographical Boundary of Responsibility of Water Management Body:

- **Hydrogeologic (capture zone, aquifer or watershed based) versus political or other:** Municipal policies apply for the municipal jurisdiction. Groundwater Conservation Authority is delineated by watershed. No real management body.

iv) Time Period of the Mandate of the Water Management Body:

- Not specified, assumption ongoing.

v) Key Participants and Roles/Responsibilities of Management Body:

- Municipal.

vi) Delegation and Decision-making Processes:

- Local level policy is at the Municipal level for development and implementation. Stakeholder input will take place after draft policies are developed.

vii) Mechanisms to Support Transparency, Accountability and Enforcement:

- None readily available.

FINANCIAL FRAMEWORK

Funding is generally carried by the municipal government, including program and policy development costs. The province provides some funding for projects, but not for staff.

DATA COLLECTION MECHANISMS

Data collection is a primary activity, particularly to delineate and map vulnerable areas, including:

- Well head Protection Areas around supply wells;
- Capture Zone Delineation;
- Capture Zone Envelopes;
- Sensitivity Assessment;
- Surface Water Intake protection Areas;
- Intrinsic Susceptibility Index Mapping; and,
- Recharge Area Mapping.

Threat identification was also undertaken with the following outcomes:

- Development of Threat Inventory Database;
- Rural non-point inventory;
- Rural point-source inventory;
- Compilation of threats in well head protection areas;
- Compilation of threats in surface water intake protection areas; and,
- Ongoing water quality monitoring.

LESSONS LEARNED

The following model was found to be the most useful in moving the program forward:

1) Identify key issues of contamination;
2) Identify where the contamination originates;
3) Determine what needs to be done;
4) Determine if there are barriers to action;
5) Remove barriers; and,
6) Act.

STUDY DETAILS

i) Case Study Representative: Leanne Lobe, Supervisor, Source Water Protection Programs

ii) Affilitation and Contact Information: Region of Waterloo - Water Services, 519-575-4765

iii) Golder Interviewer: Allison Takasaki

iv) Interview Date: February 24, 2011

v) Reference Material:

http://www.region.waterloo.on.ca/web/region.nsf/DocID/37A888F08FD43A5C85256E430075588B?OpenDocument

Water Resources Protection Master Plan, Regional Municipality of Waterloo, 2008.

BACKGROUND AND CONTEXT

i) Case Study Title:

- Rathdrum Prairie Aquifer

ii) Location:

- Washington and Idaho

iii) Land Use Characteristics:

- This aquifer is the sole source of drinking water for more than 500,000 people in an area which includes Spokane, Spokane Valley, and Liberty Lake, Washington, and Coeur d'Alene and Post Falls, Idaho. Residential, industrial and commercial uses affect the demands for groundwater. The aquifer also provides irrigation to over 10,000 acres of agricultural land.

iv) Issues of Concern/Trigger for Plan:

- As the population increases and the need for water continues to rise in the commercial, industrial and agricultural sectors, there is a greater demand for this "sole source aquifer" and its future supply to the region.
- Though the population is still rising, nitrate concentrations have continued to decrease due to the aquifer protection measures put into place which include the installation of sewers and storm water management.

v) Hydrogeological Setting:

- Unconfined aquifer: Flow rates in some areas as fast as approximately 18 meters/day.
- Recharge of ~951 million gallons/day. Discharge of ~949 million gallons/day.
- The aquifer covers approximately 370 square miles.

vi) Groundwater Use:

Community water systems: (47.7%)
Agricultural irrigation: (34.3%)
Individual domestic wells: (12.2%)
Commercial/industrial (self-supplied): (5.8%)
http://pubs.usgs.gov/sir/2007/5041/

GROUND WATER PROTECTION MECHANISMS

i) Volunteer Mechanisms:

- Public outreach in the forms of:
  - Education which promotes the conservation and a reduction of water use. This is reported to be done at the local level in Coeur D'Alene and Post Falls;

Note: Interviewee not sure what methods are used to promote water conservation.

- Public outreach in the forms of open houses and information sessions;
- Dissemination of reports published during studies;
- Publishing news releases and fact sheets;
- Website; and,
- Public and professional presentations and seminars.

ii) Regulatory Mechanisms:

- The installation of sewers and storm water management, but interviewee not aware of other (if any) mechanisms currently in place in Idaho.

iii) Regulatory Framework:

a) Provincial (or US State) Regulatory Environment

- The 2008 Idaho Legislature approved House Bill 428 and House Bill 644, establishing the State-wide Comprehensive Aquifer Planning and Management Program and the Aquifer Planning and Management Fund. This legislation authorized characterization and planning efforts for ten different basins in the next 10 years.

b) Local Regulatory Environment

- In November 2006, Kootenai County residents approved Resolution 2207-09 to form the Rathdrum Prairie Aquifer Protection District. The district encompasses the area over the RPA and the surrounding upland areas that contribute water to the aquifer. Residents of these areas pay approximately $6 per household and $12 per business to fund aquifer protection activities.

Note: These “activities” have yet to be defined.

MANAGEMENT FRAMEWORK

i) Type of Water Management Body (or Bodies):

- A Comprehensive Aquifer Management Plan (CAMP) program, created under the Idaho Water Resources Board (IWRB), has been established in Idaho to develop management plans, though it is not regulatory. The CAMP was established to address future water needs and conservation measures for the future.
- An adaptive management approach has been proposed for the CAMP (October 2010) as an improved method of decision-making. An Advisory Committee is responsible to manage, offer recommendations and guide the process along.
- The IWRB hired Collaborative Processes® LLC to facilitate the development of the Rathdrum Prairie CAMP.

ii) Mandate of Water Management Body:

a) Vision, Goals, Objectives, Principles of Operation

- The objectives of the CAMP are as follows:

(Note: Though these are the objectives of the CAMP, none of these objectives have been implemented as of yet)

  - Provide reliable sources of water, projecting 50 years in to the future;
  - Develop strategies to avoid conflicts over water resources;
  - Prioritize future state investments in water; and,
  - Bridge the gaps between future water needs and supply.

b) Formal Allocation of Authority (*e.g.,* from province)

- State agencies manage water allocation and water quality. The CAMP has yet to allocate authority to the participating members.

c) Existence and Form of A Strategic Plan of Action

- Discussions are in progress for a plan of action in regards to CAMP and the future water needs of the community.

d) Procedural Rules

- Not developed at this point.

iii) Geographical Boundary of Responsibility of Water Management Body:

- This aquifer crosses two states (and two or more counties). According to the interviewee, Idaho and Washington to do not share any responsibility in regards to the aquifer (*i.e.*, regulations, management, laws etc.). The only shared project so far has been the Aquifer Atlas that was developed in conjunction with the USGS and the two states.

iv) Time Period of the Mandate of the Water Management Body:

- The CAMP has been put into place to manage the supply and demand needs over the next 50 years.

v) Key Participants and Roles/Responsibilities of Management Body:

- The following list of key agencies is referenced throughout the October 2010 CAMP:

  Note: Though the names below are listed as key agencies, the CAMP may not be currently using all of them in their decision-making process. The roles and responsibilities have not been established for these participants. Public meetings are held to involve the public in the decision-making process. The interviewee mentioned that a representative from the Washington Department of Ecology (WDE) attends public meetings the CAMP's Advisory Committee holds as their contribution to the CAMP.

- Rathdrum Prairie Aquifer Protection District;
- Idaho Department of Environmental Quality;
- Washington Department of Ecology;
- Idaho Department of Water Resources;
- Idaho Panhandle Health;
- Idaho Water Resource Board; and,
- United States Geological Survey.

vi) Delegation and Decision-making Processes:

- The roles and responsibilities have not been established for these participants, nor have concrete decisions been made to date.

vii) Mechanisms to Support Transparency, Accountability and Enforcement:

- None have been established because no participants have been delegated responsibility.

FINANCIAL FRAMEWORK

In 2003, Congress appropriated $500,000 for the first year of the study. A memorandum of understanding was signed by the U.S. Geological Survey, the Washington State Department of Ecology, and the Idaho Department of Water Resources to work jointly on the project. Eventually, additional funding was supplied by congressional appropriations and the Idaho and Washington state legislatures, and staff support was provided by state agencies. The project was completed in 2007 at a total cost of approximately $3.5 million.

The cost of implementation should be shared by a variety of funding partners including, but not limited to: the State of Idaho, water users, non-profits, non-government organizations, and federal sources. The State of Idaho will be responsible for no more than 60% of costs, and water users will be responsible for no more than 40%. (Note: this cost allocation is not confirmed to be established as of yet).

The interviewee stated that they are in the process of determining where to get funding for the CAMP. The CAMP is currently being funded by the State through the IWRB but future funding is currently being discussed. Some sources for future funding include private, state and federal funding.

DATA COLLECTION MECHANISMS

In 2003, Idaho, Washington, the IWRB and the Washington Department of Ecology signed an agreement with the USGS to acquire data that would help model the aquifer and determine future water needs (and availability) for the public along with all parties involved. The USGS provided their expertise, data and analysis to help form a model, a hydrogeologic framework and water-budget report and a recharge report in 2007. The USGS along with other environmental agencies provide an impartial and data-driven interpretation of the aquifer. The IWRB has in-house hydrologists and hire private consultants to help with their data acquisition and interpretations.

LESSONS LEARNED

The IWRB hired Collaborative Processes® LLC to facilitate the development of the Rathdrum Prairie CAMP.

Note: This document (below) gives an overview of what has been done in regards to the SVRP aquifer and its management so far and suggests what action is necessary for its future. This document also includes interviews with some of the major participants who are involved with the aquifer in difference capacities. The page numbers of useful headings have been provided.

http://www.collaborativeprocesses.com/PDFfiles/RP_AssessmentFinal.pdf

The following points were listed as common values between the individuals interviewed by Collaborative Processes in regards to the future of the aquifer:

1) Preserve the quality of life in the region.
2) Recognize that the communities in northern Idaho have an abundance of high quality water, although the timing and location are not always as needed.
3) Maintain river flow and lake levels.
4) Take the long-view in terms of managing land and water in the region.
5) Manage water to promote responsible growth.
6) Protect existing water rights.
7) Recognize and seek to prevent potential threats to the aquifer.
8) Respect and seek to accommodate downstream needs.
9) Promote voluntary, incentive-based efforts to conserve and reallocate existing water resources.
10) Build on recent and existing examples of regional cooperation.

Divergent perspectives:

1) How and when to engage the state of Washington.
2) Who is entitled to what (in regards to sharing between domestic, agricultural, commercial/industrial and with aboriginal water rights).
3) How best to treat wastewater.

Issues and some **potential solutions**:

1. Surface-ground and quality-quantity interactions.

Re-evaluate proposals in groundwater management plan or create new plans.

2. Water supply and availability.

Multiple suggestions include managing population growth upstream, volume limits of water use, water permits.

3. Existing water uses and rights.

Water adjudication process in Idaho and Washington needs to be advanced, monitor water use, create aquifer management options, negotiations over aboriginal water rights.

4. Wastewater treatment and disposal.

Improve treatment facilities, apply wastewater to land, limit or prohibit on-Site sewage disposal.

5. Water quality.

Monitor and measure water quality in Spokane River and Lake Coeur D'Alene.

6. Land and water use.

Regulate land and water uses, impose fees for use of aquifer, more attention to future land use developments and limiting/controlling their water use.

7. Coeur d'Alene Tribe's water rights.

Educate themselves over water rights claims, consider this in the CAMP development.

8. Regional cooperation.

Promote communications between regions, identify solutions that meet the needs of both states.

9. Civic and political will.

Advisory committee to convene regularly and have forums for public involvement, increase public knowledge of aquifer and its issues through education campaigns.

STUDY DETAILS

i) **Case Study Representative:** Sandra Theil

ii) **Affiliation and Contact Information:** Idaho Water Resources Board and CAMP representative 1 (208) 287-4881

iii) **Golder Interviewer:** Neeka Mottahedeh

iv) Interview Date: February 10, 2011

v) Reference Materials:

http://www.idwr.idaho.gov/WaterInformation/projects/svrp/PDFs/SVRP_Scope_of_Work_July_7_2003.pdf

http://www.deq.idaho.gov/water/data_reports/ground_water/rathdrum_prairie_aquifer_atlas_entire.pdf

http://www.idwr.idaho.gov/waterboard/WaterPlanning/CAMP/RP_CAMP/RathdrumCAMP.htm

http://www.idwr.idaho.gov/waterboard/WaterPlanning/CAMP/RP_CAMP/PDF/Brochure_RathdrumPrairie.pdf

http://wa.water.usgs.gov/projects/svrp/data/SVRPpgminfo.pdf

http://www.collaborativeprocesses.com/PDFfiles/RP_AssessmentFinal.pdf

http://wa.water.usgs.gov/news/2003/news.SVRPsigning.htm

http://www.deq.idaho.gov/water/prog_issues/ground_water/rathdrum_prairie_aquifer/index.cfm

http://www.idwr.idaho.gov/WaterInformation/projects/svrp/PDFs/SVRP_Scope_of_Work_July_7_2003.pdf

http://www.idwr.idaho.gov/WaterBoard/WaterPlanning/CAMP/RP_CAMP/2010docs.htm

http://www.idwr.idaho.gov/WaterBoard/WaterPlanning/CAMP/RP_CAMP/PDF/2010/10_8_10_RP_CAMP_Draft.pdf

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BACKGROUND AND CONTEXT

i) Case Study Title:

- Southern Willamette Valley Groundwater Management Area

ii) Location:

- Albany to Eugene, Oregon – approximately 230 square miles within the Southern Willamette Valley and encompasses the Springfield metropolitan area, the 100 year Willamette River floodplain, and tributaries the flow into the Willamette River.

iii) Land Use Characteristics:

- Primary land use is agriculture (seed and field crops) with smaller residential, urban, commercial and industrial, forest, and wetland areas. Over 93% of the GWMA is agricultural land, a majority of which is used for crops, and a small number of large animals (cows, horses, and llamas).

iv) Issues of concern/trigger for plan:

- The Oregon Groundwater Protection Act states that if there is widespread groundwater contamination believed to be from non-point source pollution, the Oregon Department of Environmental Quality (DEQ) is required to step in to assist communities in reducing contamination through research, education, public outreach, and community involvement. If groundwater nitrate levels are measured at or above 7 parts per million (ppm) as a result from non-point source contamination, the region is declared a Groundwater Management Area (GWMA) and the DEQ is required to establish a committee of affected citizens and other interested parties to advise state agencies mandated to develop and implement action plans to reduce contamination.
- Studies undertaken in 2000-2001 sampled 476 wells and approximately 100 were found to have nitrate at or above 7 mg/L. The wells were re-sampled in 2002 with the same findings, some with levels as high as 27mg/L. The wells with nitrate levels over 7 mg/L were generally shallow groundwater wells.
- Southern Willamette was designated a GWMA in 2004 and is one of three GWMA's in Oregon.

v) Hydrogeological setting:

- Shallow and unconfined. In some areas, the shallow groundwater overlies a layer of the deeper regional aquifer.

vi) Groundwater Use:

- Private wells, public drinking water, irrigation, industrial operations, and other. 12,500 of 21,200 residents live in urban areas and rely on the public water system for their drinking water. The remaining 8,700 utilize groundwater from household wells for their drinking water.

GROUND WATER PROTECTION MECHANISMS

i) Volunteer Mechanisms:

- The committee for Southern Willamette involves three counties. In initiating the committee process, the DEQ approached the board of commissioners at each county and requested a representative. Key interest groups were identified and approached for nomination of members. This approach was taken to attempt to get the right representatives on the committee. In general, people were eager to participate, especially form the agricultural community. The committee is in its 7th year of operation and member engagement remains high, as does community interest. Educational events and public participation are a key aspect of the Action Plan development and implementation process. Residents can participate in ongoing voluntary collection and analysis of samples from neighbourhood domestic wells.

ii) Regulatory Mechanisms:

- Since the approval of the Action Plan in 2006, programs have been established in priority areas to reduced nitrate levels. Programs in agricultural areas include financial incentives for:
  - Conservation crop rotation,
  - Cover crops,
  - Nutrient management,
  - Irrigation water management, and
  - Irrigation system upgrades.
- An agricultural chemical removal project gave farmers a risk free opportunity to get rid of old chemicals, which resulted in the safe removal of 25 tonnes of old chemicals, approximately 18 tonnes of which were pesticides, including a tonne of DDT.

iii) Regulatory Framework:

a. Provincial (or US State) Regulatory Environment:

- The groundwater management area action planning process involves the following seven steps:
  1) Documentation of contamination in a widespread area at least in part from non-point pollution sources;
  2) Declaration of a Groundwater management Area;
  3) Appointment of Advisory Committee;
  4) Development of Action Plan;
  5) Public comment and review of Action Plan;
  6) Upon approval by the DEQ, implementation and monitoring of the Action Plan and
  7) Rescinding of the Groundwater Management Area once contaminant concentrations reach acceptable levels.

- Southern Willamette is now at stage 6 of the process. The Oregon Department of Agriculture is legally bound to develop the agriculture portion of the Action Plan and undertakes the stakeholder awareness programs for the agricultural community.

b. Local Regulatory Environment:

- Program is administered at the state level. One of the goals in the Action Plan is to integrate protection of Groundwater into the country and city planning actions. This includes considering using planning actions protect groundwater and implement a central wastewater treatment system in the City of Coburg where currently residents rely on individual, onsite septic systems. Members of the local governments in Willamette Valley are members of the GWMA Committee.

MANAGEMENT FRAMEWORK

i) Type of Water Management Body (or Bodies):

- The DEQ appoints a committee of affected citizens and other interested parties to work with technical advisors and city staff to develop a strategic plan. Meetings are open to the public. Smaller, specific working groups were established to provide specific strategies for reduction of groundwater nitrate for Agriculture, Commercial and Industrial, Public Drinking Water System, and Residential. Each working group is led by Agency staff and are made up of two to four committee and professional members.

ii) Mandate of Water Management Body:

a. Vision, goals, objectives, principles of operation:

- Goals identified in the Action Plan are as follows:
  - Reduce nitrate levels to less than 7milligrams per litre (mg/L) throughout the region and sustain this reduction in order to rescind the declaration of the GWMA;
  - Disseminate information about the area to solicit input and encourage actions that will protect the groundwater resource in order to engage in and involve all groups and citizens concerns with, interested in, and/or affected by GWMA plans and programs;
  - Support efforts to reduce nitrate and protect the aquifer from other potential contaminates by encouraging both short and long-term commitments from federal, state, and local agencies; and
  - Preserve and enhance the health of the aquifer while maintaining traditional and/or locally appropriate land uses. Emphasis on the development of specific voluntary strategies that avoid leaching nitrate to groundwater.

b. Formal allocation of authority:

- Oregon Department of Environmental Quality is assigned authority for groundwater management by the Oregon Legislative Assembly Senate Bill 502 (1995).

c. Existence and form of a strategic plan of action:

- Southern Willamette Valley Groundwater Management Area Action Plan (2006) was approved by the DEQ in 2006 and is now guides the nitrate reduction programs.

d. Procedural rules:

- Land use restrictions were not put in place. Goals were established instead of restrictions. The Department of Agriculture was particularly involved with this process and remains committed to the program.

iii) Geographical Boundary of Responsibility of Water Management Body:

- GWMA boundaries were delineated based the area with the most sample sites with nitrate values greater than 7mg/L. When possible, the centreline of geographic features such as the Interstate highway and waterways were used as boundary markers. Informally considered the "toga of the dancing pig".

iv) Time Period of the Mandate of the Water Management Body:

- Not stated, however, assumption until the nitrate levels are maintained at a level less than 7 mg/L when the Groundwater Management Area is lifted. Goals are on a 1-5 year timeline.

v) Key Participants and Roles/Responsibilities of Management Body:

- Members of the Groundwater Management Area Committee include representatives from:
  - Elected office,
  - Residential and community,
  - Municipal government,
  - Local businesses,
  - Farmers and farm industry,
  - Natural Resources and Environmental groups, and
  - Other, including university and research organisations.
- Members are appointed by the DEQ and reflect the major stakeholder groups in the region. Responsibilities are as follows:
  - Provide information and recommendations to the DEQ including:
    - Practices that may be contributing to groundwater contamination;
    - Strategies to reduce nitrate in the groundwater from multiple land use groups;
    - Specific actions to implement the strategies;

- Potential capable entities to conduct the actions;
- A schedule for implementing strategies and achieving results; and,
- Measurement of significant progress and success.

- Solicit and consider input from all groundwater groups and citizens concerned with, interested in, and or affected by GWMA plans or programs.
- Ensure involvement of the public throughout the GWMA planning process.
- Disseminate information about the GWMA Action Plan and or decisions to all interested, affected, and or concerned groups and citizens.

- Four sub working groups were established to specifically discuss recommendations for nitrate reduction programs while protecting local interests in Agriculture, Residential, Commercial and Industrial, and Public Drinking Water. Each working group was led by an agency staff member and two members of the Committee members supported by public employees, technical experts and interested citizens. The Oregon Department of Agriculture participated in the Agricultural working group. Data and recommendations obtained by the working groups provided the foundation of the goals, strategies, and actions in the Action Plan.
- Public Participation was encouraged throughout the process, including input to the processes and groundwater education. The following strategies for public participation were utilized:
  - Newsletters and Articles,
  - Press Releases,
  - Presentations,
  - Posters in public places,
  - Mailings to GWMA Residents,
  - Information Distributed at Well Water Clinics and other classes, and
  - Public meetings.

vi) Delegation and Decision-making Processes:

- Decision making processes are delegated to the Oregon DEQ. The Advisory Committee authors the Groundwater Management area Action Plan which is approved by the DEQ and programs are implemented. While the DEQ must formally approve the Action Plan, the document submitted by the Advisory Committee is generally approved as submitted. Public consultation and input is a key aspect of the Action Plan development process.

vii) Mechanisms to Support Transparency, Accountability and Enforcement:

- The Action Plan includes implementation performance indicators, evaluative mechanisms, benchmarks, timelines and lead implementing entity. Goals are categorized by working group. Data from ongoing, long term groundwater monitoring will be statistically analysed and members of the GWMA Technical Staff will evaluate the data to determine if water quality is improving. As the program does not intend to point fingers at those who are contributing to contamination there is not individual accountability system for individuals or sectors. A five year analysis has just been complete for the program, including a SWOT analysis which will be used to update the action plan and reconsider priorities.

FINANCIAL FRAMEWORK

Funding for the program is limited. The DEQ funds half of the program. The Department of Agriculture holds funding allocation rights for projects the District deems as a priority. There are several grant writers who have successfully received funding for the program through Oregon State University and the Lane Council of Governments. Funding can be a challenge.

DATA COLLECTION MECHANISMS

Ongoing, long term groundwater monitoring is also planned for several types of wells, including:

- 25 permanent monitoring wells sampled and analyzed by DEQ laboratory technicians,
- 15 domestic wells sampled and analyzed by DEQ laboratory technicians,
- Voluntary Neighbourhood Network sampled and analyzed by residents,
- Public Drinking Water Supply wells tested once a year and reported to the Department of Health Services, and,
- Owners of properties with domestic wells must test for nitrate levels before real estate transfers can occur.

Data collected will be statistically analysed and members of the GWMA Technical Staff will evaluate the data to determine if water quality is improving.

Capture Zone Analysis has been done for the public water system, delineated at 5 and 10 year rate of travel. Many of the wells in the region are private and only pumped 30-40 minutes a day and have not been studied for time of travel. There is no analysis for the full management area as it is over 210 miles.

LESSONS LEARNED

Community outreach is a key focus of the program, with the goal of making groundwater protection a part of the everyday life of community members, similar to recycling. One lesson learned is not to use a long and technical name for the program as a majority of community members identified with the program objectives, but few (~15%) made the connection between the objectives and the program title. Southern Willamette suggested developing a tagline that the community can relate which should make buy-in with the project easier.

Bring in good partner agencies. Creating ownership in the program, particularity through input from existing organizations made getting things done easier.

STUDY DETAILS

i) Case Study Representative:

Audrey Eldridge, Program Coordinator, Oregon Department of Environmental Quality

ii) Affiliation and Contact Information: ELDRIDGE.Audrey@deq.state.or.us

iii) Golder Interviewer: Allison Takasaki

iv) Interview Date: February 23, 2011

v) Reference Material:

http://gwma.oregonstate.edu/gwma-committee

http://www.deq.state.or.us/wq/groundwater/gwmas.htm

Southern Willamette Valley Groundwater Management Area Action Plan, Southern Willamette Valley Groundwater Management Area Committee, December 2006.

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BACKGROUND AND CONTEXT

i) Case Study Title:

- Dayton, Ohio – Great Miami Buried Valley Aquifer System Well Field Protection Program (WFPP).

ii) Location:

- The multi-jurisdictional Well Field Protection Program (WFPP) encompasses 6,280 acres in Dayton, Harrison Township, Riverside, Vandalia, Huber Heights, and Wright-Patterson Air Force Base.

iii) Land Use Characteristics:

- Dayton's water supply comes from 6,000 miles of rivers and streams in the region. The region is residential and business oriented. The Wright-Patterson Air Force Base is located within the well field. A memorandum of understanding was signed in 1990 between Dayton and the Air Force Base to protect the local water supply.

iv) Issues of concern/trigger for plan:

- The program was triggered by recognition by Dayton of the potential for chemical contamination of the groundwater and drinking water supply from growing industrial developments. This was exemplified in 1987 when the fire department a allowed to fire at a Sherwin-Williams business to burn on the surface, rather than dousing with water which could result in groundwater contamination.

v) Hydrogeological setting:

- The aquifer in Dayton is semi confined with a discontinuous aquitard making it difficult to remediate groundwater. It is considered a Sole Source Aquifer.

vi) Groundwater Use:

- Water system services 1.7 million people over 65 square miles, aquifer stores 1.5 trillion gallons of water, and well field yields 2,000 gallons per minute.

GROUND WATER PROTECTION MECHANISMS

i) Volunteer Mechanisms:

- Program is facilitated at the Municipal level.

ii) Regulatory Mechanisms:

- Revised Code of General Ordinances (R.C.G.O.) includes provisions in the Water Department Section, primarily Chapter 53, and in the Zoning Section, Chapter 150. The WFPP was originally adopted in August of 1988, and has been amended over the years, including amendments adopted through October of 2006. The WFPP was written to promote ground water risk reduction while encouraging economic development.

- The Regulated Substance Activity Inventory Report lists any chemical that is a health threat to humans. All listed substances utilized by businesses are reported and monitored.
- In 1988 when the WFPP was established, businesses were required to report their all-time maximum inventories of regulated substances. This became the baseline for the program and the value that could not be exceeded on the site. The baseline inventory value for each business is site-specific and was determined by the businesses themselves, not the municipal authorities. Current businesses cannot exceed their baseline, and if the business moves away, the inventory baseline remains attached to the site, and any new business must comply with the existing maximum value and report to the City of Dayton prior to occupying the new site. In essence, the chemical threats to groundwater cannot be higher than the levels recorded in 1988. Any chemical spills on non-impervious ground surfaces are required by law to be reported to the Superintendent of Water Supply and Treatment within thirty minutes.
- Funds are generated from a small charge Dayton's water bills which is used to encourage industry to voluntarily lower their maximum chemical inventory. Grants are given to registered businesses that are able remove 97% or more of their maximum inventory. The larger the amount if that is removed, the larger the grant, but the business must sign a deed confirming on the new, lower maximum inventory in perpetuity. As of 2005, 17,269,517 pounds of regulated substances have been removed from 24 sites through this program.
- Dayton also has staff, including the fire department, available to assist businesses and realtors looking at properties within the WFPP as if businesses cannot meet the site specific requirements of the WFPP, their occupancy permits will be rejected.
- Forgivable loans and 0% loans are also available to assist in lowering maximums and upgrading protection measures. Forgivable loans area available to those trying to lower their maximum inventories. The funds are provided up front, and for every year they are compliant with their new target maximum, 20% of the loan would be forgiven. After 5 years of compliance, the balance of the loan would be 0. However, if target values are not met, the business defaults on their loan and it must be repaid to the WFPP.
- Zero percent loans are offered to registered companies that are investing in projects that reduce the risk of contamination. Previous projects have included underground storage tank removals and upgrades, and a building addition to house hazardous waste formerly stored outside. To be eligible, businesses must be able to prove of how the project will increase the protection of the ground water.

iii) Regulatory Framework:

a) Provincial (or US State) Regulatory Environment:

- The program in Dayton has the buy in of the Department of Environmental Protection, but the program predates any groundwater protection programs or legislation at the State or National level.

b) Local Regulatory Environment:

- Regulatory requirements are part of Dayton's bylaws and permits for occupation on land designated as part of the WFPP. This includes provisions in the Water Department Section of the Revised Code of General Ordinances (R.C.G.O.), primarily Chapter 53, and in the Zoning Section, Chapter 150, and the Regulated Substance Activity Inventory Report.

MANAGEMENT FRAMEWORK

i) Type of Water Management Body (or Bodies):

- Municipal

ii) Mandate of Water Management Body:

a) Vision, goals, objectives, principles of operation:

- Protect groundwater (drinking water) but not limit business development; no formal vision or values readily available.

b) Formal allocation of authority (*e.g.,* from province):

- Municipal initiative legally authorized through bylaws. The program is a recognised member of the Groundwater Guardian program since 1995. The Groundwater Guardian program is a national program supporting groundwater protection and public education.

c) Existence and form of a strategic plan of action:

- Not readily available.

d) Procedural rules:

- Not readily available.

iii) Geographical Boundary of Responsibility of Water Management Body:

- Great Miami Buried Valley Aquifer System; wellhead protection zones defined on a one-year time-of-travel.

iv) Time Period of the Mandate of the Water Management Body:

- The program is ongoing and has had success since 1995.

v) Key Participants and Roles/Responsibilities of Management Body:

- Each of the six jurisdictions has at least one person assigned to monitor compliance with the program. Citizen awareness campaigns are held annually to promote education of the community on groundwater issues and protection. There is also a quarterly newsletter, PROGRESS (Promoting Regional Opportunities for Growth Recognizing Environmentally Sensitive Settings) circulated to local businesses and residents with updates and information on the program.

vi) Delegation and Decision-making Processes:

- The protection program was initiated and continues to be run by Dayton with other neighbouring municipalities joining shortly after. It was known from the start the program would be multi jurisdictional as they source water is shared. Stakeholders from the neighbouring communities and stakeholders, including chamber of commerce, business, regulators, and the media, were involved from the onset and participated in round table discussions.
- The City was commissioned with the decision making processes, with the support of stakeholders. It took approximately 2 years to get the process started. The program continues to be administered at the Municipal level.

vii) Mechanisms to Support Transparency, Accountability and Enforcement:

- Dayton provides incentives for risk reduction, including removal of underground tanks and buybacks of chemical inventories. To date, 18 million pounds of baseline chemicals has been removed. Audits are done on participating businesses to confirm compliance.
- Other services provided include 300 monitoring wells, 102 protection wells, emergency response, and time critical groundwater investigations.

FINANCIAL FRAMEWORK

There is a $10million funding cap for the program. It is not clear where the initial funding was sourced, but believed to be the reimbursement for the cleanup costs for the Sherwin Williams fire. The City provides emergency response, clean up and remediation services for spills and is able, to recoup costs from parties responsible for the spill. Clean up bills are very expensive, the local air force base indicated upwards of $175 million has been spent to date on remediation.

Approximately $2.5million is collected through the water usage fees. $.5 million covers 2 full time staff in Dayton, 2.5 people at the Health district, economic development jobs in Dayton, Riverside and the Harrison Township, and a fire person in Dayton. The remaining $2 million goes towards annual operating costs and is handled by the City Wide Development Administrator.

DATA COLLECTION MECHANISMS

Data collection programs include:

- Quarterly / Monthly Water Quality / Water Level Monitoring of 160 Early Warning Monitoring Wells.
- Monitoring of 58 Investigation Wells, as needed.
- Evaluation of Ground Water / Surface Water Relationship through Piezometer, Staff Gauge and Water Quality Monitoring.

The program also has an emergency response program for spills. It is required by law for any spill on non-impervious ground to be reported to the WFPP within half an hour. Response programs include:

- Time-critical Ground Water Investigations.
- Contractual Requirement of Necessary Equipment Onsite Within 48 Hours of Notification.

LESSONS LEARNED

The initiative was framed as a financial incentive to prevent contamination rather than be left with the cost of remediation. Prior to the initiative, there was a fire at a Sherwin Williams paint store in what would become the protection area. At the same time, the LA Times ran an article about contamination of groundwater. The two events dramatically brought the need for groundwater protection to the attention of the community. Companies in the region began to see the see protective measures as a business decision to avoid paying millions in clean up fees. Chlorinated solvents also began to be phased out.

Dayton framed the water fees that fund the program as “less than a buying a Happy Meal once every three months to have a clean water supply” to put the cost into perspective. The water bill is also combined with the utility bill to lessen the perceived impact of the cost.

Dayton found strong partners in conservancy with the Miami Conservancy District who worked with farmers to implement best management programs in local farms, including chemical reduction, and the regional source water stewardship group the Hamilton to New Baltimore Source Ground Water Consortium.

Other lessons learned include fine tuning which chemicals required reporting and which need management compliance more than reporting.

STUDY DETAILS

i) Case Study Representative:

Gail Galbraith, Environmental Scientist, Environmental Manager

Michelle Simons, Interim Water Manger

Jim Shoemaker, Hydrogeologist

ii) Affiliation and Contact Information: gayle.galbraith@cityofdayton.org

iii) Golder Interviewer: Jill Sacre and Allison Takasaki

iv) Interview Date: February 21, 2011

v) Reference Material:

http://water.cityofdayton.org/Water/wellfield.asp

APPENDIX C

Input from October 5, 2011 Stakeholder Workshop: Table 1 - Criteria for Evaluating Groundwater Protection Measures Table 2 - Prioritization of Potential Groundwater Protection Measures

This table provides a summary of the criteria used to evaluate potential groundwater protection measures. Workshop participants voted on the relative importance of these criteria at the start of the workshop and again at the end of the workshop (to assess whether the discussions had altered their original perceptions), and provided comments on considerations related to these evaluation criteria. These results are described in Section 4.1 of the GMS.

Table 1: Criteria for Evaluating Groundwater Protection Measures

Criteria	Perceived Importance of Criterion		Comments
	Votes (start of workshop; n=52)	Votes (end of workshop; n=39)	
Effectiveness	21 (40.4%)	14 (35.9%)	How do you measure/quantify? Who will measure/ responsibility for reporting? Data required to assess effectiveness, but the existence of data does not define the importance. Depends on the goal of the strategy. Some measures of effectiveness are long-term. Is it integrated/ are people aware? Most important issue; if the work is not done effectively then it has been a waste of time and resources, making it difficult to try again to do it correctly; Concerned with long-term effectiveness; 10-15 years, 30 years? Effectiveness must be measurable. Relying on public honesty/so much is voluntary. Agree with 40% weighting for this criteria. Good for evaluating our options. Need to look at two sides – cost and difficulty of implementation versus impact on groundwater protection. Needs to be fact-based and measurable. Effectiveness must be weighed against other factors, such as impact to businesses (cost-benefit analysis).

Criteria	Perceived Importance of Criterion		Comments
	Votes (start of workshop; n=52)	Votes (end of workshop; n=39)	
Governance Framework	11 (21.2%)	8 (20.5%)	Lead agency needs to be able and willing to take the lead. Dedication, accountability required. Coordination of agencies required. Implementation must be measurable. There is political support; how vulnerable is this political support and are citizens concerned or demanding this? Political support (municipal, provincial, *etc.,* is important). A standardized framework for uniform work provides clarity and makes it easier for companies and workers do required work correctly. Agree with political support. There are many groups who could assume responsibility (BC Groundwater Association, City of Abbotsford, BC Water and waste Association, Health Canada, provincial health, Fraser Health Authority). Governance framework is a good criterion, but requires clarification If there is a governance framework in existence, that can be built upon; if not, political and public support is required (regulatory support). Consider moving from political support to more industry/social responsibility.
Data	2 (3.8%)	5 (12.8%)	Suggest weighting of 10%. Data quality should not govern importance. System in place for data sharing. There is somewhat sufficient data. Data can be manipulated/interpreted to meet specific interests. Some progress can be made without ALL the data. There is a lot of data but little or no data sharing is taking place across the border; need to develop improved communication between Abbotsford and Sumas; should centralize and incorporate data north and south of the border to better understand the effects of any work done.

Criteria	Perceived Importance of Criterion		Comments
	Votes (start of workshop; n=52)	Votes (end of workshop; n=39)	
Data (cont.)	(cont.)	(cont.)	Suggest a higher weighting than 15% but keep weighting for effectiveness at 40% Quantity versus quality – no data available if wells are tested voluntarily While surface water is licensed, there are minimal requirements for groundwater Data is an important criterion; where it is absent we need to obtain it (*i.e.,* metering water use). Data is very important to collect and monitor; database should be continually updated.
Funding	9 (17.3%)	5 (12.8%)	Suggest a weighting higher than 15%. Regulatory support falls apart without funding. Need a combination of support. Traditional voluntary funding program support/strategy is not that effective. New approaches to funding required (i.e. public good Best Management Plans with economic benefits). Suggested weighting of 25%. Grants need to be available as municipalities and state do not have the financial resources to do it alone and take on 100% of the costs. Costs may be small to massive. Dependant on grants, homeowners (sparse registry of private wells), water rates (Clearbrooks Water Works District, Abbotsford/Mission Water and Sewer Services). Funding is a good criterion. Extended funding helps to start the program and build momentum. Suggest defining the funding criteria more broadly in terms of economics (important for long-term viability); good business case for City and users. Funding is very important; should be weighted more than 15%.

Criteria	Perceived Importance of Criterion		Comments
	Votes (start of workshop; n=52)	Votes (end of workshop; n=39)	
Regulatory Support	9 (17.3%)	7 (18%)	Suggest weighting of 20%. Development and enforcement are different issues. No enforcement of regulations/no real monitoring. Is there support for regulation by local decision makers? Competing interests between different regulatory frameworks. Ministry of Environment could coordinate with more agencies. Could re-write Fisheries Act to cover groundwater. Regulations sometimes based on number of water connections; there are virtually no private systems. Perceived threats of regulations on commercial and industry may need education and engagement. Lots of regulations already in place for agriculture; not sure how easy it would be to develop more. Voluntary measures preferred for agriculture; regulatory enforcement not effective.

Criteria	Perceived Importance of Criterion		Comments
	Votes (start of workshop; n=52)	Votes (end of workshop; n=39)	
General comments on Criteria			Weighting of criteria depends on the protection measure; Criteria are inter-related. Suggest combining governance framework criteria with regulatory support criteria with total weighting of 20% Suggested re-framing regulatory support criteria as “Public and Stakeholder Support” (use public and stakeholder groups to assist with the implementation of protection measures) Additional criteria for consideration: “Coordination and Communication” “Public Awareness”

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This table provides a summary of the groundwater protection measures evaluated by the workshop participants. The tables summarize the advantages and disadvantages of each measure, together with the priority ranking of the measures with respect to each other based on participant votes. Potential groundwater protection measures are grouped into five different categories: groundwater sustainability (Table 2-A); regional groundwater quality (separated into Tables 2-B1 and 2-B2 to accommodate two sub-groups of workshop participants); groundwater quality related to residential land use (Table 2-C); groundwater quality related to commercial and industrial land use (Table 2-D), and groundwater quality related to agricultural use (Table 2-E). These results are captured in Section 4.2 of the GMS.

Table 2-A: Potential Groundwater Protection Measures: Groundwater Sustainability

Groundwater Protection Measures	Case Study Reference	Votes for (n=14)	Advantages	Votes against (n=12)	Disadvantages	Priority Ranking
Public education on water conservation	Rathdrum Prairie, Langley, Kelowna	4	Low cost/long term benefit No regulatory barriers Grass roots approach	0		1
Provide financial incentives (rebates) for use of low-flush toilets, water efficient appliances, grey water, rain barrels*	Oxford	0	Easy to implement Proven to reduce water use Fair; user pay principal	3	Not a significant enough issue in the City of Abbotsford therefore address through public education for now	(7)
Water use restrictions using municipal bylaws (for municipal water users/private well owners)	Langley, Oxford, Kelowna	1	Consider for water wells, geotechnical boreholes and geothermal wells	1	Most “invasive” activity, therefore caution required	5
Water use charges using: 1) a flat-rate billing structure that would not require metering, 2) a variable rate based on metering, or 3) a combination of the two	Oxford, Dayton, Parksville, Guelph	3	Variable rate preferred	1		2

Table 2-A: Potential Groundwater Protection Measures: Groundwater Sustainability

Groundwater Protection Measures	Case Study Reference	Votes for (n=14)	Advantages	Votes against (n=12)	Disadvantages	Priority Ranking
Requirements for well siting/drilling/groundwater extraction, with focus on large groundwater users (for example, mandate drilling authorizations for new wells, require hydrogeological assessments and monitoring for large groundwater extractions, or set limits on pumping volumes)	Langley, Oxford	3		0		3
Identify flowing artesian wells and ensure they are stopped/controlled	Langley	1		3	Flowing wells not a key issue in the City of Abbotsford due to the unconfined nature of the aquifer Requires a large amount of money with little benefit	(6)
Surface water use restrictions (assess existing/proposed surface water licenses in the context of base flow sustainability)	Langley	0		4	Surface water licenses already issued under the Water Act, therefore difficult to change Surface water use doesn't seem to be a problem in the City of Abbotsford	(8)
Enhance infiltration (groundwater recharge) through improved storm water management (*i.e.,* impose limitations on impervious surface areas)	Campbell River	2	Relatively effective and low cost Can be done with bylaws	0		4

Notes:

1. Potential groundwater protection measures identified from case studies referenced in Appendix B, together with knowledge of initiatives in other regions.
2. Priority rankings shown in brackets are those that received a low level of support.

***** With the exception of the use of grey water, these measures have already been implemented by the AMWSC.

Table 2-B1: Potential Groundwater Protection Measures: Regional Groundwater Quality

Groundwater Protection Measures	Case Study Reference	Advantages	Disadvantages	Priority Ranking
Purchase land corresponding to the municipal well capture zones to give the City full control over the land use activity in that area.	Oxford, PEI, Amherst		Point source solution Very expensive	(4)
Establish development permit areas corresponding to municipal well capture zones or sensitive parts of the aquifer within the Official Community Plan to restrict land use and/or activities (may include provisions for storm water management, best management practices, monitoring)	Kelowna, Cranbrook, Campbell River, Oxford, Waterloo	Low cost to implement Non-point, broadly applicable coverage Experience to draw upon Applies to new development	Private sector reaction	1
Spill response planning/training/reporting (first responders to be made aware of sensitive groundwater areas, such as municipal well capture zones, and specific provisions within those areas, such as restrictions on the use of hazardous fire retardant chemicals)	Oxford, Waterloo, Dayton, Langley	Relatively easy to implement (education, coordination and minor equipment)	Infrequent	2
Designate truck/rail routes for hazardous materials outside of the capture zones of municipal and large capacity wells and sensitive recharge areas	Waterloo	Easy to implement	Impractical given aquifer size and infrastructure New routes very costly	(3)
Additional measure identified in workshop: parking restrictions for trucks and other vehicles				

Notes:
1. Potential groundwater protection measures identified from case studies referenced in Appendix B, together with knowledge of initiatives in other regions.
2. Priority rankings shown in brackets are those that received a low level of support.
3. Workshop participants for this category did not record the number of votes for and against each protection measure.

Table 2-B2: Potential Groundwater Protection Measures: Regional Groundwater Quality

Groundwater Protection Measures	Case Study Reference	Votes for (n=8)	Advantages	Votes against (n=8)	Disadvantages	Priority Ranking
Improve the quality of storm water recharging the aquifer through enhanced treatment (i.e., wetlands, biofiltration, oil-water separators) and monitoring controls*	Rathdrum Prairie	4	Treatment of rainwater is important because we rely on it for recharge Wildlife/habitat restoration Related to water quantity and infiltration Very effective if designed and maintained properly	0		1
Enact a well closure bylaw requiring that abandoned water wells be properly decommissioned; provide incentive programs to assist with the decommissioning	Merritt	1		3	Important but there is a lack of available funding Should already be legislated and common practice for contractors	(3)
Implement a comprehensive groundwater monitoring and assessment program to inform future decision-making	Oxford, Langley	3	Important to create and populate a water quality database to see and monitor trends Allows tweaking/increase to programs while identifying trouble spots Once a problem is fixed, divert funds and time to another area with greater monitoring needs	1		2

Table 2-B2: Potential Groundwater Protection Measures: Regional Groundwater Quality

Groundwater Protection Measures	Case Study Reference	Votes for (n=8)	Advantages	Votes against (n=8)	Disadvantages	Priority Ranking
Impose requirements related to the siting, design and monitoring of geothermal wells	Bow River	0		4	Good idea but not yet a priority for Abbotsford	(4)
Additional measure identified in workshop: maintenance of healthy municipal water and sewer systems through monitoring and maintenance						

Notes:

1. Potential groundwater protection measures identified from case studies referenced in Appendix B, together with knowledge of initiatives in other regions.
2. Priority rankings shown in brackets are those that received a low level of support.

***** The CoA has a Source Control Bylaw in new industrial areas above the aquifer that partially addresses this.

Table 2-C: Potential Groundwater Protection Measures: Groundwater Quality Related to Residential Land Use

Groundwater Protection Measures	Case Study Reference	Votes for (n=8)	Advantages	Votes against (n=8)	Disadvantages	Priority Ranking
Public education on well maintenance; septic system maintenance; and proper use and disposal of household hazardous materials, lawn and garden chemicals and automotive repair chemicals (pamphlets, door-to-door visits, information sessions)	Langley	3		1	Effectiveness hard to measure	2
Extend sewer servicing to sensitive groundwater areas (i.e., rather than use of in-ground septic system disposal)	Rathdrum Prairie, Langley	0	Would reduce risks	1	Effectiveness uncertain Excessive cost Heavily developed areas already serviced	
Require minimum lot sizes and enhanced design controls *(i.e.,* nitrogen removal systems) for septic systems in sensitive areas to reduce impact on groundwater quality	Langley	1		1	Most septic systems are already on acreages Minimal benefit for the effort	3
Require on-going inspection/maintenance of approved septic systems (for example, permit to be renewed every 3 or 5 years, or in the event of a property transaction)	Thurston County (WA)	4	Effective (best way to ensure maintenance) Political support Data available Victoria currently doing this	0	Funding, implementation, support required	1
Subsidize septic system maintenance (i.e., rebates for pumping septic tanks)		0		4	Have to pump anyway Limited additional benefit	

Table 2-C: Potential Groundwater Protection Measures: Groundwater Quality Related to Residential Land Use

Groundwater Protection Measures	Case Study Reference	Votes for (n=8)	Advantages	Votes against (n=8)	Disadvantages	Priority Ranking
Provide opportunities for free residential hazardous waste collection or drop-off	Dayton	0	Agree good	1	Questionable effectiveness Drop of already available	

Notes:

1. Potential groundwater protection measures identified from case studies referenced in Appendix B, together with knowledge of initiatives in other regions.
2. Priority rankings shown in brackets are those that received a low level of support.
3. Protection measures with no priority ranking are those with a low level of support and insufficient feedback to infer a ranking.

Table 2-D: Potential Groundwater Protection Measures: Groundwater Quality Related to Commercial and Industrial Land Use

Groundwater Protection Measures	Case Study Reference	Votes for (n=6)	Advantages	Votes against (n=6)	Disadvantages	Priority Ranking
Engage stewardship groups/provide technical assistance to assist businesses with the development of best management plans	Oxford	1	Need to educate all involved parties (stakeholders, City and regulators) A good start to build involvement and engagement Go above minimum standards such as bylaws	1	First we need to ensure the stewards have the capacity/expertise	3
Restrict land use and/or chemical storage and use in municipal capture zones or sensitive groundwater areas through municipal zoning bylaws (*i.e.*, prohibit high-risk commercial and industrial activity and/or impose controls)	Dayton, Oxford	2	Appropriate tool Aligned with Official Community Plan	0	Reduces available land for development	1
Provide financial incentives for businesses to reduce the types and quantities of chemicals they use within sensitive groundwater areas (municipal well capture zones and recharge areas)	Dayton	0	May help overcome barriers if properly assessed and implemented	3	Risk of reducing responsibility/commitment if costs do not pose a barrier Creates no behavioural change; old behaviours return after incentives withdrawn	(5)

Table 2-D: Potential Groundwater Protection Measures: Groundwater Quality Related to Commercial and Industrial Land Use

Groundwater Protection Measures	Case Study Reference	Votes for (n=6)	Advantages	Votes against (n=6)	Disadvantages	Priority Ranking
Enhanced requirements for above ground and underground storage tanks (*i.e.,* provisions for spill containment, reconciliation records, pressure testing, groundwater monitoring)	Oxford	1	Easy sell Win-win; cost savings for businesses	0		4
Requirements for sand and gravel mining - best management plans with provisions for fill characterization, drainage control, groundwater monitoring, closure plans; prohibit sand and gravel mining in sensitive areas	Waterloo, Dayton, Bow River	2	Quick contamination hazard makes it a special focus Added benefits for later use as recreational properties (golf courses, lakes) Foreknown strategy for outcomes makes efficient process	0	Puts one single interest on the spot; must be a positive and supportive idea (collaborative action)	2
Require all contaminated sites in the City be remediated to soil and groundwater standards for the protection of drinking water	Langley	0	Positive impact on soil, not necessarily an impact on groundwater quality	2	Records of contamination are poor Huge cost; critical for business May create negative behaviour (hiding contamination) May reduce public and stakeholder support Poor past practices Huge step; better to be tackled later in the process	(6)

Notes:
1. Potential groundwater protection measures identified from case studies referenced in Appendix B, together with knowledge of initiatives in other regions.
2. Priority rankings shown in brackets are those that received a low level of support.

Table 2-E: Potential Groundwater Protection Measures: Groundwater Quality Related to Agricultural Land Use

Groundwater Protection Measures	Case Study Reference	Advantages	Disadvantages	Priority Ranking
Stewardship programs (for example, encourage participation in Environmental Farm Plan Program sponsored by the BC Agriculture Research & Development Corporation)	Oxford, Willamette, Waterloo, Langley	Most sustainable long-term EFP alerts farmers to areas of improvement (good benchmark) If practices are improved, there may be less need for regulations		1
Provide financial incentives to farmers to assist with nutrient management, integrated pest management, grazing management, irrigation management, water management and riparian management.	Oxford, Willamette, Waterloo	Funding allows farmers to do it themselves Financial assistance provides good incentive Meets the evaluation criteria (effective, data available, government and regulatory support)		2
Provide free technical assistance to farmers on issues related to nutrient management and irrigation (agro-consultants)	Sweden	Provides help for farmers		3
Enact a Nutrient Management bylaw (controls related to manure storage and application, intensive livestock operations, chemical fertilizers)	Oxford		"Stick" rather than carrot approach Already lots of unenforced regulations. Hard to enforce; creates hostility Creates uneven playing field for producers if only enacted in one area	(6)

Table 2-E: Potential Groundwater Protection Measures: Groundwater Quality Related to Agricultural Land Use

Groundwater Protection Measures	Case Study Reference	Advantages	Disadvantages	Priority Ranking
Enact other locally-enforceable agricultural controls (i.e., a Farm Bylaw with provisions for proper storage of fuel and wood waste, prohibiting the discharge of agricultural waste and wood waste, requirements for certified irrigation plans).	Langley		"Stick" rather than carrot approach Already lots of unenforced regulations Hard to enforce; creates hostility Creates uneven playing field for producers if only enacted in one area	(5)
Provide opportunities to drop off agricultural chemicals and pesticides for proper disposal at no charge*	Willamette		Should already occur as a better business practice; greater priorities to focus on	(4)

Notes:
1. Potential groundwater protection measures identified from case studies referenced in Appendix B, together with knowledge of initiatives in other regions.
2. Priority rankings shown in brackets are those that received a low level of support.
3. Workshop participants for this category did not record the number of votes for and against each protection measure.

* The CoA recently held a successful pesticide drop off in 2011.

APPENDIX D

Studies and Initiatives

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Numerous stakeholders, both government and community, are currently actively pursuing various initiatives that directly and indirectly address aquifer issues. These include the advancement of the science of groundwater in the aquifer by institutions of higher learning, regulatory requirements and standards by governmental agencies, and BMP (Best or Beneficial Management Practices) type stewardship initiatives by both agricultural and industrial stakeholders in the community.

GOVERNMENT

Federal Government

Environment Canada

- Groundwater modelling and monitoring (including routine, long-term monitoring of groundwater level and chemistry at monthly and annual sampling intervals at up to 60 piezometers and spatio-temporally high-resolution groundwater level monitoring using pressure transducers at 22 locations)
- Isotope study for determining nitrate source (manure versus synthetic fertilizers)
- Passive diffusion sampling to resolve vertical nitrate patterns and near-field inputs
- Trans-boundary water issues
- Research on emerging contaminants of concern (e.g., pharmaceuticals), surface water-groundwater interactions, climate change impacts

Agriculture Canada

- Soil, crop, nutrient research

Health Canada

- Canadian Drinking Water Guidelines

Provincial Government

Ministry of Environment

- Groundwater monitoring
- Ground Water Protection Regulation (currently covers well drilling and construction practices; but intended to expand to protect quality and quantity)
- Living Water Smart plan (cites intention for government to regulate groundwater use in priority areas and large groundwater withdrawals)
- Agricultural Waste Control Regulation

Ministry of Agriculture and Food

- Environmental Farm Plans (voluntary)
- Manure management strategy (policy)

Fraser Health Authority

- Drinking water protection plans
- Drinking Water Protection Act regulations
- Community water system water quality overview

Local Government

- Water Master Plan & POLIS Soft Path water conservation
- Groundwater modelling (water balance, capture zone delineation)
- Source Protection Bylaw and associated regulations
- Zoning Bylaw restrictions on hazardous uses over aquifer(prohibited uses)
-

COMMUNITY STAKEHOLDERS

Sustainable Poultry Farming Group (SPFG)

- BMPs/Codes of Practice

BC Auto Recycler's Association (BCAR)

- BMPs/Code of Practice
- Pollution prevention plans
- Annual inspections

Greenhouse Growers Association

- Water conserving computerized irrigation systems
- Closed loop irrigation systems (recirculating water)
- Rainwater (roof) collection systems and retention ponds

Clearbrook Water Works District

- Abandoned well inventory

Universities

- Simon Fraser University groundwater modelling
- University of British Columbia groundwater research
- University of Calgary groundwater research (isotope study and passive diffusion sampling)

APPENDIX E

Suggested Action Plan Framework

Appendix E - Suggested Action Plan Framework

Water Resource	Objective	Issue	Data Gaps	Action	Proposed Groundwater Protection Measure
Groundwater Quantity	Preserve the sustainability of the Abbotsford-Sumas Aquifer	Increased groundwater demand	Water balance analysis (assess previous studies, refine if required)	Groundwater level monitoring and assessment	Requirements for well siting/drilling/groundwater extraction
		Unrestricted groundwater extraction		Water well inventory and estimate of groundwater usage (starting with large users)	Water conservation program (public education, water use charges, water use restrictions)
				Estimate future groundwater demands (all sectors)	
				Estimate effect of climate change	
		Reduced groundwater recharge		Estimate groundwater recharge	Stormwater management (enhanced infiltration)
		Reduced surface water baseflows		Assess baseflow conditions	Evaluate surface water allocation*
				Estimate surface water usage	
				Conduct hydrologic monitoring	
Groundwater Quality	Protect regional groundwater quality (Abbotsford-Sumas Aquifer, municipal supply wells and private water supply wells)	Stormwater runoff	Capture zone analysis (assess capture zone analysis of AMWSC wells and refine if required; conduct capture zone analysis of CWD wells); Contaminant inventory of capture zones and update of regional contaminant inventory.	Assess/prioritize contaminant sources/risks	Stormwater controls**; groundwater monitoring and assessment
		Hazardous spills		Identify all sectors and activities requiring spill response plans	Spill response planning/training/reporting
		Transportation and utility corridors		Assess/prioritize contaminant sources/risks	Designated transportation routes*
		Improperly constructed/adandoned water wells		Inventory of private groundwater wells	Well closure bylaw*
	Protect groundwater quality from residential land use	Septic systems; household hazardous materials		Nitrogen loading analysis	On-going inspection/maintenance of septic systems; public education; minimum lots sizes; groundwater monitoring and assessment
	Protect groundwater quality from commercial/industrial land use	Chemical storage, use and disposal; above ground and underground storage tanks		Identify existing stewardship associations and BMP's; assess/prioritize contaminant sources/risks	Land use and/or chemical storage restrictions through municipal zoning bylaws and/or development permit areas; BMP's for sand and gravel mining; engage stewardship groups/provide technical assistance; enhanced requirements for above ground and underground storage tanks; groundwater monitoring and assessment
	Protect groundwater quality from Agricultural land use	Pesticide and fertilizer use		Nitrogen loading analysis; assess/prioritize contaminant sources/risks	Stewardship programs; financial incentives; free technical assistance on issues related to nutrient management and irrigation; groundwater monitoring and assessment

Notes:
MAL = BC Ministry of Agriculture and Lands
MOE = BC Ministry of Environment
MMER = BC Ministry of Mines and Energy Resources
AMWSC = Abbotsford Mission Water Services
CoA = City of Abbotsford
CWD = Clearbrook Waterworks District
EC = Environment Canada
FHA = Fraser Health Authority
SFU = Simon Fraser University
BMP = Best Management Practices

* Low-level of support for these protection measures in October 5, 2011 stakeholder workshop.
** The CoA has a Source Control Bylaw in new industrial areas above the aquifer that partially addresses this.

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